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ISLANDS AND THEIR MYSTERIES

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A VOLCANIC ISLAND

Showing the entrance to the harbor created in the former crater.

ISLANDS AND THEIR MYSTERIES

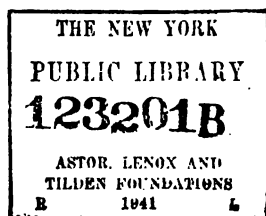
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BY
A. HYATT VERRILL
Author of
"The Ocean and its Mysteries"

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NEW YORK
DUFFIELD AND COMPANY

1920
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Printed in the United States of America

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INTRODUCTION

IN the preparation of this book no attempt has been made to produce a learned or scientific treatise on islands, but rather, to describe, in a clear, concise and easily understood manner, how islands are formed, how they resemble or differ from one another, how they become covered with vegetation and are inhabited by animal life, and to explain the causes and the reasons for many of the most puzzling and interesting features of islands and insular life. In order to make the matter still clearer and more vivid, chapters have been devoted to imaginary trips to various types of islands where the peculiarities, the formations, the vegetable and animal life, the marine fauna and the forces of Nature which have a bearing on the islands are viewed and studied at first hand.

Finally, accounts of some really remarkable islands have been included for the human in-

INTRODUCTION

terest they possess, and the author has touched lightly upon the romance of islands and their influence upon the development and history of the human race.

Much valuable and accurate information regarding geology, botany and natural history has been woven into the text, but in such a simple manner and so free from technical and scientific terms that it easily may be grasped and understood, even by young readers.

It must be remembered, however, that in a book of this scope it is quite impossible to treat of all islands, or even of a very small percentage of them, and that, in the descriptions of imaginary trips to various islands the author has presented islands which are, in reality, composite pictures of various islands, thus in one island combining in the features and peculiarities of a number belonging to the same general type or class, and thus avoiding the necessity of visiting widely separated islands for the purpose of studying some one or two special characters or peculiarities which exist only on certain islands.

INTRODUCTION

The author has spent many years on islands, especially on those in tropic seas and tropical lakes and rivers, exploring, collecting and studying, and he has always found that islands possess a strange fascination and attraction. This feeling, he believes, is shared by many people who will welcome a volume treating exclusively of islands and explaining much about them which is a puzzle to many.

In a way, this book is a companion volume to "The Ocean and Its Mysteries," for islands and the oceans have such a direct bearing upon each other that, to thoroughly understand the one, it is essential that we understand the other and if this work serves to convey a better understanding of islands; if it adds to the public's interest in islands, or if the island-lover finds within its pages facts or knowledge which are new, or even if it serves merely to while away a pleasant hour, the purpose of the book will be accomplished.



ISLANDS AND THEIR MYSTERIES

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MYSTERIES**

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discoveries and surprises! Once beyond its fringe of brush and blueberry bushes one seems in a strange, new land cut off from all the world, even though a scant half mile of water separates it from a farmhouse or a village. One feels that within its thickets may lurk strange and savage beasts, that its copses may hide unknown secrets, that somewhere upon it may be a robbers' or a smugglers' cave or even that upon some rock or tree may be a strange symbol which, read aright, will lead to buried treasure-trove. And as boyhood gives way to manhood do we not still feel the same old thrill, the same appeal to our imagination when, on some tropic sea we approach an unknown island with its snowy strands bare of human beings, its towering mountains covered with forests untouched by axe, its waving palms beckoning us to land? And as we step ashore do we not feel our pulses quicken, our nerves tingle and our common sense desert us as in our schoolboy days of old? It makes no difference if the island lies in the beaten track of great steamers or is in almost uncharted seas; it matters

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not if the seas about it are turquoise under tropic skies or green under northern skies of gray, for the lure is there, the mystery, the possibility for a venture and discovery—for is it not an island, and in this fact alone lies all the subtle charm and attraction. From the very beginning of time islands have had a strange fascination for mankind and ever since men first began to tell stories, islands have held a prominent part in all their tales. Sinbad the Sailor had some marvelous adventures on an island; Gulliver's Travels were mainly to strange, unknown islands; the Greek heroes sought the Golden Fleece and performed many of their most memorable deeds on islands. Enchanted castles and fairies have been located on islands by all nations; Shakespeare knew the romance and the fascination of islands and laid the scenes of his "Tempest" on one of them. Half the interest of Robinson Crusoe's story lies in the island on which he was shipwrecked; the Swiss Family Robinson were cast away upon a most remarkable island, and Jules Verne was alive to the appeal which islands possess when




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boundaries of their homes could not be extended as on a continent, and as the island people increased and produced more than they could use they were obliged to depend upon commerce and shipping for their livelihood. So, too, they soon learned that it was a difficult matter for an enemy to follow them across seas to their islands and, knowing this, they made war upon other nations and turned corsairs and pirates and performed reckless feats of daring which they never would have attempted had they dwelt on the same land as their victims, who might have retaliated at any time. And with the increase of their race and the necessity for more room, came the conquest of other islands and of portions of the mainland until the little groups of islands, which had originally been their homes, controlled countless thousands of square miles of other territory and countless thousands of other people. The history of every island race is the same, be they naked savages or the most highly civilized of men. The Greeks conquered and colonized many lands; the British acquired the greatest em-

pire in all the world; the Caribs of the West Indies were feared throughout the coasts of South America, and the Malays raided and conquered far and wide, and, in every case, these islanders have been bigger, braver, stronger, more intelligent and more reckless than their fellows on the continents for, after all, it is commerce and the control of the seas that control the destinies of the world.

As it is with the insular nations as a whole, so it is with the individual, and among the great men of the past and present we find that a very large number came from islands. Napoleon from the Island of Corsica; Dumas from the Island of Haiti; Alexander Hamilton from the Island of Nevis, are but a few of the famous men who were born upon tiny bits of land surrounded by the mighty sea. And, as we look carefully through our histories, we will find that many an important event, many a great battle, many a happening which has changed the course of nations and has had a mighty influence upon civilization and mankind has taken place upon some island.



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of Haiti, is famous as being the first spot settled by Europeans in America and for the fact that it was here that Columbus was in chains and here his body still lies, and the island of Jamaica was where he foretold the eclipse of the moon. Newfoundland is famed everywhere for its fisheries and has become still more famous since the first non-stop aeroplane flight across the Atlantic started from its shores. The tiny Galapagos Islands off South America are famed for their giant tortoises hundreds of years old; Ceylon is famed for its teas and Java for its coffee; Trinidad for its asphalt; Bermuda for its vegetables and the fact that it was the scene of Shakespeare's "Tempest." The Canary islands are known to everyone as the original home of the most common of cage birds, and there are countless other islands whose fame has spread throughout the world, and they are not all large islands either, for size has little to do with fame and some of the most famous of all are tiny islets which appear like mere dots upon the map.

CHAPTER II

ISLANDS AND ISLANDS

THERE are almost as many different kinds of islands as there are sizes and scarcely two are alike, or even remotely resemble one another. There are islands which are high, with lofty mountains piercing the clouds; there are islands so low as scarcely to be visible a short distance away; there are islands bare, forbidding and desert-like and there are others heavily wooded, rich with vegetation and gorgeous with flowers. Some islands have rocky shores carved and worn into picturesque forms by the sea; others rise in sheer precipices from the waves; others have tiny coves and harbors, and others possess long, crescent-shaped beaches of sand. Many islands are well watered and have tumbling rivers and beautiful cataracts, while others are dry and without water. Mountainous islands may be flat-topped, or their hills may form a jagged chain

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or a confused mass of peaks, while others may taper upwards from the sea in a single-sky-piercing cone. Many islands are honey-combed with caves and caverns, but many others have no caves at all. Some islands teem with bird and animal life and many others possess no native birds or mammals. Man has dwelt since prehistoric times on certain islands and yet others, which appear just as well adapted to man's use, have never been inhabited, for islands vary just as much in their characters and appearance as do continents. And now the question arises as to what is an island and what a continent. Some authorities have claimed that any body of land containing two distinct mountain ranges is a continent, but there are many islands with two or more distinct ranges of mountains and if this definition is accepted, the world would lose many of its most famous and important islands. If the difference between a continent and an island is merely one of size, where do we draw the line? Australia is the largest recognized island, but is Greenland an island or a continent?

Moreover, many islands are merely the tips of continents which have been submerged; but if North America should sink until only the tops of its mountains and highlands rose above the water would it become an island or would it still remain a continent? It is a puzzling matter really to say just where an island and a continent differ, and the easiest way out of the question is to call any body of land cut off from adjacent lands by water an island.

And just as islands vary in form and size and appearance, so do they vary in their characters, their formation and the reason for their existence. There are volcanic islands, coral islands, limestone islands, sand islands, rock islands and even floating islands and islands which are combinations of two or more of these, each with its own peculiarities, its own characters and its own interests.

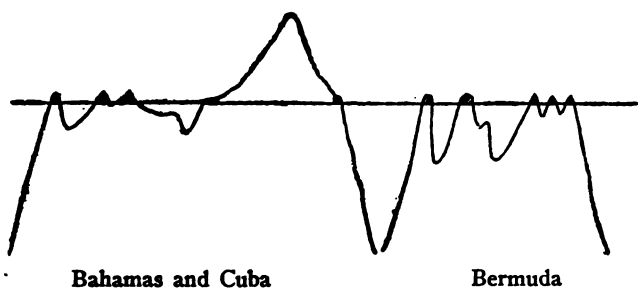
It is hard to say just which kind of island is the most numerous, for in some places one kind is more common than another, while in other places every kind is represented. But there are also certain kinds of islands which

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are never found save in certain parts of the world. Coral islands, for example, can only occur where corals grow and hence all coral islands are in tropical or semi-tropical seas, while islands formed by ice action are never seen save in arctic or semi-arctic seas. Even among the various kinds of islands I have mentioned there are many varieties of each, for almost any kind of an island may be formed in any one of several different ways. Thus, volcanic or coral or rocky islands may be formed either by subsidence, by uprising or by volcanic action or even by erosion. Sandy islands may be formed in any of these ways or by winds or waves in addition, while floating islands or islands in lakes may be formed in any one of several ways.

When we see an island we seldom stop to think about how it was formed and still less often do we think how it would appear if there was not water surrounding it, for as we see it, it gives the effect of resting *on* the water rather than in it. But if the water should be drained from the sea we would be wonderfully surprised to see how the islands would

appear. When we look at an island with great mountains towering upwards for five or ten thousand feet above the sea we are greatly impressed and are even awed by the sublime sight of the peaks rising from the sea; but imagine what these would look like if the water was not there. Many of the loftiest islands are surrounded by water many times



as deep as the islands are high. In other words, their height from the bottom of the sea to the surface of the waves is far greater than the height of their tallest mountains above sea level. Thus, if the water was drained from the sea about Cuba and the Bahamas one would see, instead of a sloping coast rising gradually through hills to the Sierra Maestre of



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but which come so near it that a very slight subsidence of the sea or a very slight uprising on the earth below would transform these so-called "banks" and reefs into islands. And such slight changes may occur at any moment and they may be gradual and take thousands of years as the banks move upward inch by inch, or they may occur suddenly and an island may rise from out the sea in a few hours or even minutes, and such things have happened many times within the memory of man. So too, islands which rise above the sea may be lowered or even sink far out of sight beneath the waves either by slow degrees or suddenly, and this, too, has occurred within historic times. Indeed, there are few islands which are not constantly rising above or sinking below the sea, though so gradually that we cannot detect it, while others have been raised far above their present level and have been sunk down, or have been buried far beneath the waves and have then been raised; so you see, islands are far from being the stationary, solid things we usually consider them, and almost any island, no matter how large, may be here


today and gone tomorrow for all anyone can say.

But there are certain kinds of islands which do not subside or rise up. These are the floating islands which occur in certain parts of the world and which, instead of being fastened to the bottom of the lakes or rivers where they occur, actually float upon the surface. You may think that these must be very small and unstable islands, but this is not the case. There are floating islands scores or even hundreds of acres in extent and bearing large forests and even houses and villages upon them and which you would never suspect were resting upon the surface of the water like enormous verdure-clad boats. There are also certain kinds of islands which may appear or disappear very suddenly without being pushed up or sunk down. There are sand islands which may be formed or destroyed in a single day or night of storm and which are constantly changing in size and form. Still another class of islands which appear slowly to rise from the sea and which are not pushed up from below are coral islands, for true coral



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islands grow until they reach the surface of the sea and then begin to increase and rise above the waves by sand and drift stuff accumulating on them. Thus, an island may be made by a combination of two distinct kinds of islands or by half a dozen kinds for that matter, and each and every kind or combination of kinds may be formed by any one of an almost endless number of ways, or by a still more perplexing combination of ways, and as all this is a very important and very interesting matter we must consider each kind of island and discuss all the various means by which it may be formed.




CHAPTER III

VOLCANIC ISLANDS

MANY of the most famous and most remarkable islands, and also many of the largest islands in the world, are volcanic islands. But this term "volcanic" covers a great many forms and kinds of islands, for any island which is formed by volcanic action is a volcanic island, and yet it may not have any volcanoes or even signs of volcanoes upon its surface. Roughly speaking, volcanic islands may be divided into three classes, as follows:

- 1. Islands which consist of one or more volcanoes.**
- 2. Islands which are composed of lava or other matter thrown out by volcanoes.**
- 3. Islands which have been forced up from the bottom of the sea by volcanic action, but which have no volcanoes upon them.**



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Oftentimes an island may be a combination of all three of these classes, and still oftener all three kinds may occur in the same chain or archipelago of islands which may all be related to one another and formed by the same volcanic action.

The commonest form of volcanic islands is that on which there are volcanoes, although to the casual observer there may be no signs of them, for the volcanoes may have been dead so long that they have been eroded and altered until they do not resemble craters or cones in the least. But it must always be borne in mind that a volcano never is really dead, but that it merely sleeps, and no man can say when an apparently dead volcano may burst into life with terrible results, for the term "dead," as applied to volcanoes, refers only to the fact that they are not active, and the word "inactive" is far better and more accurate. Many of the worst catastrophes the world has known have been due to the sudden awakening of a sleeping or so-called "dead" volcano. The awful eruption in Martinique in 1902, which destroyed the entire town of

St. Pierre and killed nearly 30,000 people, was from a long "dead" volcano, Mont Pelée. This mountain, which towered upwards for nearly 5,000 feet, a few miles from St. Pierre, was not only inactive, but held a good-sized fresh-water lake in its ancient crater, and yet, without any apparent reason, it suddenly came to life with terrific results. The same was the case in the neighboring island of St. Vincent, the two eruptions being coincident; but there was no apparent increase in the activity of really active volcanoes in the nearer islands of Dominica—barely thirty miles from Martinique—in St. Lucia, scarcely farther away, or in Guadeloupe, or St. Kitts, all of which have active volcanoes which constantly emit boiling water, steam and gases from their craters. So you see it is not always the active volcanoes which should be feared, but rather the dead ones. Perhaps the most disastrous eruption of a volcanic island in historic times was the eruption of Krakatoa, a large island in the Indian Ocean which, without any warning, was blown to atoms with all its inhabitants. So

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fine were the particles into which the island was pulverized and so far were they blown by the explosion, that for many months the dust of Krakatoa caused the sunsets to be strangely colored in reds and yellows throughout the world.

The causes of these unexpected eruptions are not known precisely and many theories have been advanced to account for them. The most generally accepted one being that a crack opens beneath the sea and permits the water to reach the hot interior of the volcano and the steam thus generated, together with the other gases, blows off the top of the volcano.

When such an eruption takes place it is always accompanied by terrific earthquakes and usually by great changes in the land and also in the sea-bottom in its neighborhood. The land may be raised many feet or sink as many feet in a few hours and shallow spots in the sea may become almost fathomless, while deep places may become shallow or even be forced up above the sea and made into islands. But as the sea is of much greater area than the land and as we cannot see the changes which

occur beneath it, we do not always realize the great alterations which a volcano may cause.

At the time of the Martinique eruption the bottom of the sea was greatly changed in the vicinity of the island; but the island itself was very slightly altered, if at all. On the other hand, some volcanic disturbance, or even an earthquake, far beneath the surface of the sea, may produce marvelous changes on the nearby islands. A few years ago a good-sized island suddenly rose above the sea off the coast of Trinidad in the British West Indies. It was new-born land, wet, muddy and bare, but it was land nevertheless and apparently stable. The authorities visited it, took possession as a dependency of Trinidad and set up the British flag, but a few days later this new acquisition to the British Empire disappeared as suddenly as it had appeared and ships now sail over the spot. The same has occurred in other parts of the world. One large rocky island came into existence off the Alaskan coast. It was discovered by a United States naval vessel while still so hot

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that the officers reported that sea-birds, trying to alight on it, burned their feet. It was charted and reported, but a short time afterwards had disappeared completely. Even when an eruption or an earthquake does not alter the island directly it may produce results which in a few years completely change the appearance of an island. Stupendous quantities of mud, lava or cinders may be thrown out and block rivers, thus changing their courses; bays and harbors may be filled up or may become so shallow that they become swamps, or bars may be formed across their mouths so that they are transformed into lagoons or lakes, or great valleys may be sealed and in a few months become filled with rain water and thus become big and beautiful lakes.

Such things are not always accompanied by eruptions or even by earthquakes. The little island of Grenada, one of the West Indies, is a decidedly volcanic island with several enormous and apparently "dead" craters among its mountains, but there has never been an eruption within historic times

and severe earthquakes are not common and yet, within the memory of man, great changes have been wrought in the island by volcanic action. The harbor of St. Georges, the capital, is really an ancient crater and one day the water suddenly became agitated and rose several feet, flooding the streets of the town and destroying many small boats. It then receded until the bottom of the harbor was bare, only to rise again and again recede several times. When, at last, it quieted down and the water resumed its original level, the Grenadians discovered great alterations had taken place in their beautiful harbor. Across the bay, where there had been solid land and an ancient fort, was now a deep hole in the sea, while the former inner harbor or carenage, which had always accommodated the largest ships, was now but a shallow pool with a bar across its mouth. The Grenadians were fortunate, for there was no loss of life during the strange disturbance; but in some places such sudden changes in volcanic islands have been accompanied by great losses of property and lives. In the old pirate days, Port Royal,

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Jamaica, was noted throughout the world as the foregathering place of the sea-robbers and it bore the reputation of being the "richest and wickedest city in the world." Then, one Sunday morning, without a moment's warning, there came a severe earthquake and most of Port Royal sank beneath the waves, carrying with it scores of the pirates with all their booty and ill-gotten gains. Since then many other severe earthquakes have taken place in Jamaica and several other sections of Port Royal have shared the fate of the piratical rendezvous of yore while the city of Kingston has been almost utterly destroyed. And yet, while Jamaica is of volcanic origin, there are no recognizable volcanoes on the island and Port Royal is built upon a sandy point and not on volcanic formations.

A still worse catastrophe occurred in Nevis, which is a true volcanic island with a single, cone-shaped volcano rising from the plains and with numerous hot springs to prove that the old giant only slumbers. Nevis, in the old days, was a favorite watering place for all the society of Europe and the West Indies, but

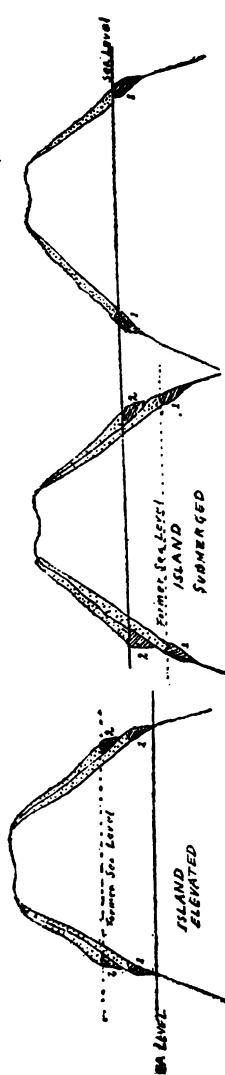
the chief town, Charlestown, shared the same fate as Port Royal, the entire city sinking suddenly under the sea, and today, in clear weather, one may row above the submerged town and, looking through the crystal-like water, may trace the outlines of the streets and buildings of the once gay and populous town.

And that the same sort of thing has occurred in the dim ages of the past on a stupendous scale is proved by an examination of the rocks on many volcanic islands. In many places, especially in the West Indies, one finds sea-shells and fossils high up on the mountain sides and many thousands of feet above the present sea level, thus proving that at some former time the islands were far beneath the sea with only the very summits of the highest peaks above the waves. Moreover, on many of these islands, one may find great reefs of coral high up on the mountains with hundreds of feet of lava or tufa below them and below this again more coral reefs, more lava and still more coral, all of which proves conclusively that these islands have risen and fallen thousands of feet over and over again—veritably

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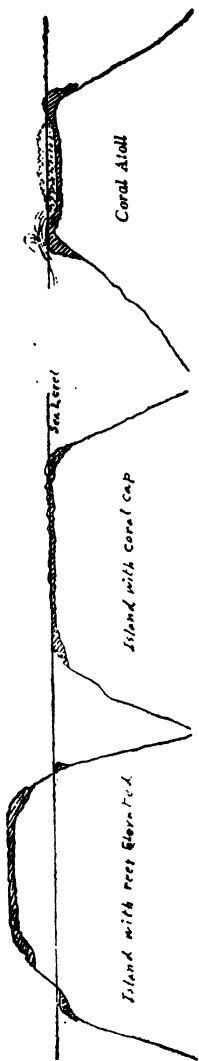
like jumping-jacks. And as many of the corals and shells are of the same species as exist in the surrounding seas today we know that these mighty changes did not occur so many countless ages of years ago. No doubt most of the alterations were very gradual and it may have taken thousands of years for the island as a whole to rise or to fall a few feet, but there are places where, by the conditions in which the corals and lava occur, we know that tremendous changes occurred in a very short time.

Even today, these islands are either rising or falling constantly and old sea-walls, which were built by the early settlers at the edge of the beach, are now covered by many feet of water, while others, which had become submerged and forgotten are constantly appearing from the water and are once more serving their original purpose, for the surface of the earth, with its rocks, its mountains and its valleys, instead of being the solid, inflexible thing we consider it, is, in reality, like putty in the hands of Nature and constantly is being moulded and changed and



Low = Coral

SECTION OF ISLAND WITH REEF SHOWING: 1, SUBMERGENCE. 2, ELEVATION



Coral

ELEVATED CORAL REEF

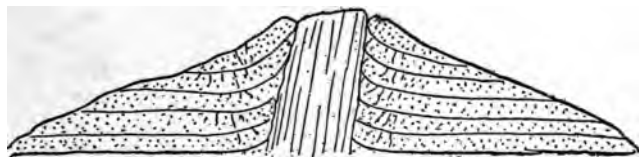
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altered by the stupendous forces of volcanic action, by shrinkage, by earthquakes and by pressure. And just as those islands which bear volcanoes are being raised or lowered, so, too, other masses of the earth's surface, which have no signs of volcanoes upon them, are being pushed up or lowered, and in the past geological ages, when the world was young and in the making, such changes were millions of times greater and took place with far greater rapidity than at present.

This brings us to the second class of volcanic islands which have no volcanic cones or craters, but which are composed of material thrown up by volcanic disturbances. In many places these originally did have volcanoes upon them, but through the ages the cones and craters have worn away until today the entire islands are masses of laval rock or tufa with no signs of the original craters from which the material came.

In other cases, islands of this sort are close to true volcanic islands and may originally have been connected with the latter, while in still other cases, the lava-like material was

pushed up through cracks from the interior of the earth and had no connection with volcanoes upon the surface of the earth. Such masses of rock are known as "igneous intrusions" and islands formed by them are more correctly called igneous islands than volcanic islands; but as igneous and volcanic matters



IGNEOUS INTRUSION

are so closely associated, and as they often occur together, it is hard to distinguish between the two. Igneous intrusions usually occur in cracks in other and softer rocks, and these, through the action of waves and wind and rain and exposure, gradually decompose and wear away, to leave the harder, igneous rocks remaining. Islands formed in this way are usually precipitous, with high, rocky cliffs marking the edges of the crack through which the molten rock was forced, and they are often flat-topped or nearly so. Many of


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and grottoes which at last cave in and undermine the cliffs, often in enormous masses. In time, however, these fallen rocks serve as natural breakwaters or barriers and protect the very cliffs from which they were torn; but, oftentimes, the island rises from deep water and the rocks broken from it afford no protection and the cliffs are gradually eaten further and further inland until the debris piles up and forms a barrier. But even then the action of frost and wind and storm continues until, in time, the solid, precipitous, rocky island may be reduced to a low pile of broken stone, or if of large size, the cliffs may disappear and the island may have rounded, gently-sloping hills rising upwards from the sea to the rocky backbone.

This erosion is a very great factor in the making of islands and in the alteration of their shapes. Sometimes the rocks are cut completely down in spots, thus making two or more islands out of one, or again, the material torn from one island may be carried by the sea and piled up somewhere else to form another island.

While the elements are ceaselessly wearing away the hills and mountains and transforming the raw and jagged outlines of the mountains into rounded and smoothed forms, and as the rains and frost and winds cut the rock and pile it between the hills and scatter it over the surface, it gradually decomposes and forms earth. Then vegetation covers it and binds it together and gradually protects the island from the erosion which has produced it, so that the elements are constantly defeating their own ends and there at last comes a time when the waves beat impotently upon the beaches and shingle they have formed and the rains pour harmlessly upon the forests, and the wind howls, baffled, about the verdure-clad hills and only the frost continues slowly to work its destructive forces on the solid rocks.

And if the island lies in warm seas where there is no frost, only the torrential rains and the flooded rivers have any appreciable effect and the island remains, to all intents and purposes, unaltered through the centuries until some earthquake or volcano overwhelms the



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vegetation and alters the river courses and forces new-made masses of forbidding rock to the surface, to be again worn and carved and softened by the elements, for in Nature there is an ever-constant struggle, a ceaseless war between titanic forces, and islands are among the greatest of Nature's battle grounds.

CHAPTER IV

CORAL ISLANDS AND OTHER ISLANDS

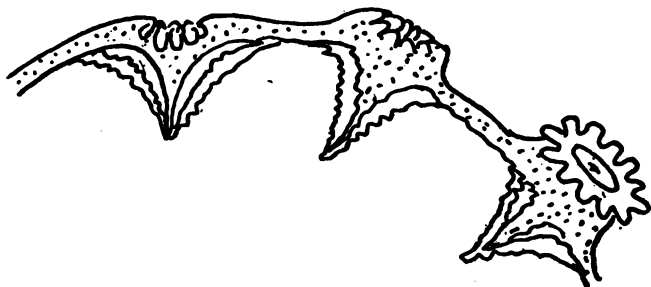
VERY different indeed from the wild, chaotic, awe-inspiring forces which produce volcanic islands are the quiet, invisible means which Nature employs in building the coral islands of tropic seas. But just as there are various kinds of volcanic islands, so, too, there are several classes of coral islands, and while any coral island may be a combination of several kinds and while one class may grade into another, yet, in a way, all coral islands may be divided into three classes, as follows:

1. True coral islands.
2. Coral atolls.
3. Coral islands of Aeolian rock.

Although we are prone to speak of "coral" islands as though they were made entirely of

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solid coral, yet in reality such coral islands are very scarce and can only be formed with the aid of volcanic or earthquake action. Corals will not and cannot grow above the surface of the sea, although they may thrive where they are bare during low tide, and hence, unaided, they cannot produce islands of coral as we recognize it. But they may



SECTION OF CORAL

grow so abundantly and so close to the surface that, even if their supporting rock is not elevated an island will be formed, for once the corals are exposed to the elements they die and are broken up by wind and waves and the resulting sand fills in and builds up an island with sand-dunes, hills and beaches all composed of pulverized coral. Or again, a sub-



CORALS, ANIMAL LIFE ETC., FOUND ON A LIVING CORAL REEF. (Much enlarged.)

[REDACTED]

[REDACTED]

[REDACTED]

merged mountain or tableland may become covered with coral many feet in thickness and then, if the mass is elevated above the sea, an island may be formed which, to all intents and purposes, is coral, for the core of volcanic rock may be quite invisible and only determinable by deep borings through the coral covering.

Of all coral islands the Atolls are the commonest and in a way the only real coral islands. Strictly speaking, an Atoll is a circular or semi-circular island or elevated reef enclosing a lagoon; but Atolls may be of almost any shape and may have no lagoon and yet be formed exactly as a true Atoll. But it must be borne in mind that even Atolls must have a foundation of other material, for corals do not build up from the sea-floor until they reach the surface. The majority of reef, or island-building corals cannot exist in deep water where the temperature is always low, for at a few hundred feet beneath the surface the water is as cold in tropical as in northern seas. And in many cases Atolls, which at first appear to be entirely of coral formation with

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all their soil and hills and land composed of pulverized, wind-blown coral, are in reality but the rims of ancient volcanic craters covered with a superficial coral coating.

But by far the greater number of so-called coral islands are really formed of Aeolian rock or, in other words, a limestone formed of wind-drifted sand, composed of fragments of coral and sea-shells, which has solidified and become rock. The Bermudas, the Bahamas, many of the West Indies, and many other islands in tropical seas are of this formation. But even in these there is an underlying foundation of igneous or volcanic rock upon which the corals have grown. It is quite possible for islands of Aeolian limestone to be formed and built up into high hills and cliffs without the foundation rocks being elevated, for, as in the case of Atolls, as soon as the coral growth comes near the surface of the sea it ceases to grow upwards and spreads out over a wider and wider area until many square miles of former submerged banks and reefs may be completely covered with coral which is bare at low water, or which is within a few

inches of the surface of the sea, or they may form barrier reefs about lagoon-like expanses of comparatively shoal water. In either case, they serve to break the force of the waves and, as bits are broken from them by the waves, the pieces are piled up and accumulate on the masses of coral, or in the shoal water behind them. Then, as the force of the waves is broken by the outer reefs, these odds and ends remain undisturbed and gradually fill in and smother the corals and form more or less solid land, while, along the outer edges, the corals continue to grow and increase the area of the whole. With the bits of broken coral and shells came flotsam and jetsam from the sea, bits of wreckage, masses of seaweed and kelp, floating seeds and cocoanuts, and all the thousand and one odds and ends that the sea ever carries hither and thither with its currents.

All these help to build up the newly-formed island. The mangrove seeds take root and grow in the shoal waters and droop their aerial roots to form other trees which soon form a labyrinth to catch and hold mud and sand and anything else that washes in among

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them, and thus still further break the force of the waves. Soon behind this guardian fringe of living trees the sand piles up and bars and beaches appear; the cocoanuts take root and wave their plume-like leaves like banners of victory above the waste; the wind whips the loose sand into hills and hollows; sedges and grasses and coarse shrubs and vines bind the grains together, and lo, we have an island, green with vegetation, but of loose, unstable sand. But as all this sand—composed wholly of broken coral and shells—is largely of carbonate of lime it is partly soluble in rain water and so, as the rains percolate through it, the lime is dissolved and carried down and gradually cements the grains of sand into solid rock. Then more sand accumulates, more rock is formed, the waves and wind and rain cut and carve it into cliffs and ravines and valleys; the weeds and vegetation die and decay; the rock decomposes and soil is formed, and in time rich verdured land with high, rocky hills and beetling cliffs occupy the place where once a coral reef spread itself beneath the waves. But for one

reason or another some portions of the sand never harden into rock, but remain through countless ages as loose, free sand. Sometimes these masses of sand form huge, irregular pockets, while at other times they occur in layers between strata of hard rock, and as the sand is washed or blown out by rain, wind or waves, grottoes and caverns of every imaginable size and shape are left. Sometimes these caves are below sea level, at other times their floors are covered by the sea, while in other cases they are high above the water. After the sand has washed or blown away and the caverns are left, the rain water, percolating through the rock above, deposits masses of lime on the interior of the caves and forms marvelously beautiful stalactites and stalagmites, the former being pendent, tapered or conical masses of stone from the roof, while the stalagmites rise upward from the floor and are formed from the lime-impregnated water dripping from the stalactites. As the one grows downward and the other builds up they eventually join and form ringed and fluted columns of translucent white, pink, or

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countless billions in the sea and, as they die, their shells or skeletons sink to the bottom and form beds of lime of immeasurable depth. Of course it takes millions of years for these almost microscopic creatures to accumulate to this extent and it takes millions of years more for them to be transformed to chalk and still more millions of years for them to rise from the sea and form great masses of land such as portions of England. Other limestone islands are formed in much the same manner, but of different material. In these, the rock is merely the petrified mud of the sea or lake bottoms, and although very hard yet, upon examination, we may see that it is full of fossil shells, corals, crustaceans and other forms of marine life. Many of our northern islands are of this sort and it is very interesting to pick out the various fossil animals and to know that the hard, limestone cliffs were once the mud at the bottom of the sea or the mud-flats of some ancient estuary. Such limestone islands usually contain many caves and grottoes, for limestone is a comparatively soft rock and is partially soluble

in rain water, and the water, finding its way through cracks and crevices, cuts out hollows and caverns which are decked with dripstone, just as are the caverns in Aeolian rock.

Many limestone islands, as well as islands of igneous rock, have been formed by erosion and were once portions of the mainland, and through great lapses of time have been cut off and separated by the action of frost, rain, wind and waves; but every limestone island, or every bit of mainland made of limestone (always excepting Aeolian rock) was at one time beneath the surface of the water and has been pushed up by subterranean forces, so, after all, they are caused really by the same action as many volcanic and coral islands.

Just as the chalk, composed of the remains of millions of tiny creatures, and the limestone, which was once mud with its shells and marine life, have been pushed up from the sea's bottom, so, in places, we find islands of sandstone which were once sand bars or sandy areas under the sea. Often, in the solid rock of such islands, we may find the imprints of rain-drops and the wavy lines caused by

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ripples upon the beach when the island was still soft sand, and, at times, we may even find the clearly marked footprints of some prehistoric giant lizard which wandered along the shores of the ancient sea searching for any morsels the receding tide might have left.

Unlike limestone islands, sandstone islands, were not necessarily pushed up from below the sea, for many were formed by sand piling up at the mouths of rivers or bays and gradually hardening into rock. Today one may see such bars forming and oftentimes they grow to large size and become respectable islands by the wind blowing the sand into dunes and hills while the waves or the currents keep adding more sand to the edges. As a rule, however, such sandy accumulations are very unstable and may be completely destroyed and washed away in a single storm, and even when they do remain they are ever shifting and moving and seldom remain quiet long enough to become solidified into rock, unless the sand is composed of limestone and is rapidly cemented together by the action of rain water.

Sandy islands are far commoner in rivers and lakes than in the sea, for in such places they are not exposed to the irresistible force of great waves. In rivers they are particularly common, for the current, always flowing in one direction, has a tremendous tendency to build up islands upon the slightest interruption to its flow. Oftentimes the nucleus of some huge island in a river may be a most unexpected and insignificant thing such as a stone, stick, log or even a bit of some old wreck. Near the mouth of the Essequibo River in British Guiana there is a big island nearly ten miles in length which is known as Dauntless Island and which has been formed within the memory of living men. This island gets its name from the fact that it was entirely formed through a vessel named the *Dauntless* being wrecked in the river. Just as soon as the wrecked vessel obstructed the current, sand began to accumulate behind and around it; floating sticks and logs lodged on the sand causing still greater obstructions and the accumulation of more sand; floating seeds found a roothold and grew into sedges and

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coarse water-plants, and each thing added formed a greater barrier to the flowing water and allowed more sand to be deposited. Then came the mangroves—the marvelous, land-building trees of tropic waters—then larger trees and, in a few years, a forest-clad island rose from the river where the ill-fated *Dauntless* had gone down.

There is also a class of islands, which may be of volcanic or of igneous rock or of limestone or of sandstone, or even of loose sand, which are formed in a different way from any I have described. To this class belong many of the islands in the world, perhaps, indeed, the majority, for some of the greatest archipelagos were formed in this way—that is, by subsidence. Just as submerged mountains may be forced up from the bottom of the sea to become islands, so vast masses of land may sink down until only the tops of the mountains remain above the water and form islands. If the North American continent should sink a few hundred feet the various mountain ranges, such as the Alleghanies, the Rocky Mountains, the Sierras and the Cascades would be

all that remained above the sea and would thus form long archipelagos of rocky islands, while the western plains and deserts would be enormous seas or lagoons. In past ages such conditions actually existed and if the bottom of the Gulf of Mexico and the Caribbean Sea should be uplifted in the same way as was North America, we would see a vast area of plains bordered on the east by a stupendous mountain range whose tips are now the Lesser Antilles; with an aggregation of lower mountain peaks above a tremendous plateau where now are the Bahamas; with vast bulky mountain masses which would dwarf Mt. Everest and which we now know as Cuba, Haiti, Porto Rico and Jamaica and with isolated, slender pinnacles marking the innumerable tiny islands which dot the Caribbean Sea. Thus the same conditions which make islands into continents may also produce islands, for, by an upward motion of the earth's crust, the summits of submerged mountains may become islands, while existing islands may be transformed to mountain ranges rising from a continent, whereas, a sinking of the earth's sur-

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sand and gravel as it moved on its irresistible course, and using these like cutting tools to work its will upon the earth beneath, the glacier found itself conquered at last by the sun and the sea and, as it melted and broke up, the stones and boulders and gravel dropped from its grasp and formed islands in lakes and in the sea. Long Island was formed in this manner, and in many of our lakes we may find islands composed of the boulders, sand and gravel dropped by the glaciers, while still others were formed by the glacier cutting away the softer material which once filled the hollows which are now lakes. Much of the material thus deposited by the glaciers was brought, locked in the ice, for thousands of miles, so that islands thus formed may be of very different material from the surrounding country, and it is therefore an easy matter to determine if an island was produced in this way. It is also a very simple matter to determine whether or not an island of rock formation has been subjected to glacial action, for the deeply-cut grooves made by the loose stones in the grasp of the ice as it passed over

cliffs and ledges still remain clear and distinct and unlike anything else. But it is by no means easy to be positive whether such islands and the lakes were formed by the glacier, or whether they existed before, or whether they have been created by changes in the earth's crust since.

But perhaps the strangest of all islands are floating islands. These do not occur in the sea, but are confined to lakes and rivers and are mainly found in tropical countries for cold weather, frosts and ice do not permit the formation of floating islands.

In the tropics, however, where the vegetation grows luxuriantly throughout the year, these strange islands form rapidly and are very common under proper conditions. A floating island usually starts with a dead tree, a floating log, a mass of leaves or grass or, in fact, any object which is floating on the surface of a lake or sluggish river. Upon this foundation seeds are dropped by birds, other seeds, drifting about, find lodgment upon it, and with the marvelous rapidity and virility of tropical plants they sprout and grow until,

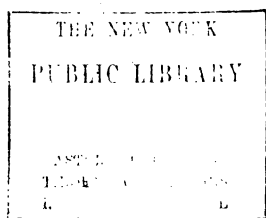
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presently, the bit of flotsam is hidden by a little mass of greenery which constantly increases in size as grasses, brush and vines are added to it. Oftentimes, the miniature floating island grounds upon some sunken log or snag, or upon some jutting point or shoal and, ere it can float free, it becomes firmly anchored by the innumerable dangling roots of its vegetation. But, if fortune favors, the little island continues to drift hither and thither at the will of wind and current, and ever increasing and growing and eventually supporting a forest of good-sized trees whose interwoven roots form a stable and tough framework upon which the decaying fallen leaves build up a solid mass of vegetable mold. On some of the Mexican lakes, as well as in Venezuela and elsewhere, these floating islands grow to large size and the natives build their villages, raise their crops and even pasture their burros and goats upon them.

In many tropical rivers there are floating islands of a different sort, but which, at first sight, might be mistaken for them. In many parts of South America the rivers rise many



STALAGMITES AND STALACTITES IN A CAVE ON A LIMESTONE ISLAND.



feet during the heavy rains and the forests are flooded for miles. These forests are made up largely of trees with broad, spreading, surface roots, for the soil on which they grow is shallow and composed of vegetable mold resting upon a hard clay or rock foundation, and during the floods large masses of the forest floor often float free and are carried down the river with all their giant trees, their tangles of hanging lianas and their animal life undisturbed. The traveller in these districts may camp upon solid land in the forest, only to find himself upon a jungle-clad island a few hours later. On one occasion I made camp in the Guiana forest, stretching our shelter and slinging our hammocks between immense trees upon a little knoll, and when we awoke the next morning found our camp upon a wooded island several miles below the spot where we had gone to sleep and with a mile or more of water between us and the forest.



CHAPTER V

ISLAND LIFE

THERE are very few islands in the world which do not support animal life of some kind. Even the most desolate and barren islets teem with life, though they may appear absolutely deserted and devoid of living creatures to the casual observer. Where islands are near land or are in lakes or rivers, the life upon them is usually much the same as that upon the neighboring mainland, for insects and birds fly back and forth, mammals and reptiles swim from shores to island and, as far as most of their life is concerned, they often are merely detached bits of the neighboring country. But even then there are almost always certain forms of life which seem to prefer an insular existence and which are seldom seen upon the mainland in the vicinity. Many water fowl roost and nest upon islands in lakes, bays and rivers, but never on the shores near-

by; certain beetles and moths and butterflies frequent the islands and may be very common there and yet very rare elsewhere; mammals of various kinds may find the islands a safer home than the main and may increase and multiply until they are far more abundant than anywhere else in the vicinity, and even marine or fresh-water animals may abound upon a tiny islet and yet may never be found in the surrounding waters. There are many reasons for this, some of which have never been fathomed, but the principal reason is the same which first led man to dwell on islands and that is—protection. Many of the predatory mammals, especially the cats, dislike to swim, and hence the birds and small animals on which they feed are far safer and are less liable to be preyed upon if they live upon an island with a barrier of water about it. So, too, an island affords a clear and uninterrupted view in all directions and approaching enemies may be seen and avoided much more easily than upon the mainland. For birds or animals that feed largely upon aquatic life islands afford better homes than the main for


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they find a far greater area of feeding grounds close at hand. Finally, there is the question of certain plants or vegetation which occur only on islands and which certain insects or even birds may require. It is far more difficult to understand why some marine or aquatic animals should be confined almost entirely to islands, for the shores and the waters apparently differ in no way from those of the mainland nearby. But whatever the reasons, the fact remains that practically every island, or group of islands, has a fauna more or less distinct from that of the neighboring country, and this is true of the north as well as of the tropics.

In Long Island Sound there is a little group of islands off the Connecticut coast which are known as the Thimble Islands. The largest of these is only a few acres in extent and the outermost is but two miles from shore, and yet these tiny islets support, in addition to the fauna of the nearby coastal lands, a number of species of birds, insects, marine animals and plants some of which have never been found elsewhere and many of which are extremely

rare on the land less than two miles distant. Several species of birds abound and nest upon these islands and yet they have never been recorded from the mainland in the vicinity; mink, which are very rare on the mainland, swarm upon the islands; butterflies and moths of species never seen upon the mainland flit about the flowers and the larvæ eat the leaves of the island vegetation. Some of these have never been recorded from any other spot within several hundred miles of the islands, and a certain species of earwig, which is very abundant on these islands, is only known from one other locality and that an island also—the Bermudas.

But strangest of all is the fact that on the granite ledges and in the limpid tide-pools of these islets are found certain species of sea-anemones and molluscs which have never been recorded from any other spot in the world! And the conditions existing on this little archipelago are but duplicates of conditions existing on many other islands in our bays and lakes. It is very easy to understand how a certain species of plant or animal may increase



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and become very abundant if it once secures a foothold upon an island where it is free from destruction by enemies; but it is difficult to understand why or how certain species should occur there and not be known from any other locality within hundreds of miles and, apparently, the only explanation is that such species were at one time found on the neighboring mainland, but that through some cause they were exterminated and only those representatives of their kind on the islands survived.

Whatever the reason, it is extremely interesting as it throws a light upon the origin of the innumerable strange and remarkable forms of life which are peculiar to many islands which are more distant from the continents and from one another. We can easily see how forms of life such as I have named, and which were almost entirely condemned to an insular life would gradually adapt themselves more and more to their island surroundings and would slowly acquire peculiarities and characteristics which would result in their becoming totally distinct from their relatives

of the mainland, and this is precisely what has occurred on many islands in the ocean, and the very fact that this is so proves how extremely ancient are such islands and how long ago it must have been since they were connected with one another or with the continent.

One might expect to find such distinct forms of life among mammals, insects, reptiles and plants, but we would scarcely look for it among the birds which can readily fly back and forth from island to island or from island to continent, and yet it is among the birds that we find the greatest number of species peculiar to certain islands. The vast chain of islands, which we known as the West Indies, stretches in a huge semicircle from the tip of Florida to the tip of South America, and nowhere in all that chain is there a space of open water over one hundred miles in width. And yet every island in the West Indies has species of birds, as well as insects, reptiles and mammals, peculiar to itself. By this I do not mean that all the birds or other animals on one of these islands are different from all those on another,

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for there are many species that are common to all the islands, other species occur on several islands, and many other species of birds from North America migrate through the West Indies. But aside from all these, there are a number of species which never occur except on their own islands. Thus, the various islands have parrots and parroquets peculiar to themselves and all very distinct from those found elsewhere in the world, and yet some of the Lesser Antilles are but fifteen miles apart! The same is true of humming birds, of doves, of finches, of orioles, of fly-catchers, of warblers and of practically every genus of bird found on the islands. There is no earthly reason why a parrot or a humming bird or any one of these various birds should not fly from island to island all the way from Cuba to Trinidad or why any one of the various species should be better adapted to one island than to another, or why they ever should have confined themselves to one islet until they became distinct species; but the fact remains that it is so and it is one of the unsolved riddles of Nature.

But it is a still greater mystery as to why certain families of birds should be well represented on some of these islands while, on a nearby island there should be no species of the family. Thus, there are woodpeckers on many of the islands, and yet on other islands, less than twenty miles distant, woodpeckers are never known. Similar conditions prevail among the mammals, and while it is easy to understand why the mammals have never travelled about from island to island, it is by no means easy to explain why a certain creature, like the Armadillo, occurs on many of the islands, then is absent from a number of islands, and then bobs up again on islands beyond. The probability is that in former times such mammals occurred on all of the islands and that from some cause or another they became exterminated on certain islands and, being unable to migrate from other islands, they have never been replaced. The very fact that such creatures cannot swim for any distance goes to prove that the insular fauna of these islands dates back to the time when they were all connected and were also

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attached to either one or both of the American continents.

Still more remarkable than the Antillean bird fauna is that of the Island of Cozumel off the coast of Yucatan. Here, close to the mainland of Central America, and far from any other islands, we find an island with an immense number of bird species found nowhere else in the world and yet there is not one that could not easily fly back and forth between Cozumel and Central America. Even such tiny isles as the Bahamas have species of birds and reptiles peculiar to themselves, and oftentimes the smallest islands have the greatest number of peculiar species.

But the differentiation of insular forms of life in the West Indies is nothing compared to that in the East Indies and the South Seas. In these islands we not only find species peculiar to each island, but, in addition, we find families and even orders of animals which do not exist elsewhere, while on some islands the mammalia all belong to a single order, and that an order that is scarcely represented in any other part of the globe.

Thus, on Australia every mammal which is a native of the island belongs to the marsupials, or animals which carry their young in a pouch or pocket of skin on the abdomen, and there are very few marsupials found in any other part of the world. In Australia, however, there are insectivorous, herbivorous, carnivorous and omnivorous marsupials; crawling, hopping, climbing, swimming, running and burrowing marsupials; gentle and savage marsupials; useful and destructive marsupials; marsupials that are nocturnal and marsupials that are diurnal; marsupials that range in size from the giant kangaroos to the tiniest of mice; marsupials that are the counterparts in appearance of nearly every known animal; some that look like rats, others that seem to be bears; others that resemble gophers; many that we would recognize as opossums; some that at first sight would be mistaken for cats, and others which might be wolves or wild-dogs, while many are utterly unlike any other creatures known to man. And not to be outdone by the weird aggregation of mammals on this largest of islands, the

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birds have gone also to extremes. Nowhere in all the world are there so many or such gorgeous species of parrots; nowhere else do such cockatoos occur; in no other land do we find parrots so large, with such strange forms or with such remarkable habits, and nowhere else do we find a score of species, of genera and of families of birds which abound only in Australia.

But bizarre as are the marsupials, rich and remarkable as are the birds of Australia, it is on the islands of Mauritius, Madagascar, Tasmania and New Zealand that we find the real freaks of nature which are peculiar to these islands. Was ever bird more weird and remarkable than the extinct Dodo? Was there ever a more gigantic or more peculiar bird than the Moa, which may well have been the original of Sinbad's famous Roc. Can human mind invent, or man's imagination picture, a more unnatural, impossible beast than the New Zealand Duckbill? A creature furred like a beaver, with the bill and feet of a duck, with the structure of a mammal and, withal, living under water and

laying eggs. Nature went to extremes when she conceived the Duckbill and she must have been in the same mood when she produced that other New Zealand monstrosity, the Apteryx—a wingless, tailless bird with hair for feathers! Strangely enough this tendency for insular life to become weird in appearance, remarkable in form and paradoxical in habits is not uncommon, and there are few large islands with a distinctive fauna which do not boast at least one grotesque freak of bird or mammal.

Unfortunately, however, these bizarre creatures are usually both stupid and helpless, due no doubt to having been evolved in an environment where they had few if any enemies, and they have always fallen an easy prey to man. The Dodo was slaughtered and hunted down for its meat and fat and was soon exterminated; the gigantic Moas disappeared from the earth centuries ago; the Apteryx is already on the verge of extermination; the Wekarail is practically extinct; the strange, gigantic petrel, known as the Diablotin and once abundant on Dominica Island in the West Indies,

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is now little more than a myth; the Solenodons of Haiti and Cuba exist only in restricted localities, and the Duckbill and Echidna and many other furred and feathered denizens of islands have shared the same fate.

Many of these strange birds and beasts, which to our eyes seem veritable monstrosities, are really little else than left-overs from pre-historic times and are very similar to creatures which existed when the world was young and which are known to us only by their fossil skeletons and remains. Strangely enough, the same isolated conditions of an insular life which have produced distinctive species and adaptation to surroundings in some cases, have tended to preserve and perpetuate obsolete and primitive forms in other cases, and, for all we know, strange survivors of distant geological periods may still exist, unsuspected and unknown on some of the little-explored islands that dot the seas. The Moa lived until comparatively recent times and the natives insist that it still exists; the Dodo was abundant in the days of the early Portuguese discoverers, and the Duckbill, the Echidna, the Ap-

teryx are all creatures which are the sole survivors of forms which were numerous and widely diffused in prehistoric days, while the whole vast array of marsupials belong to a primitive type.

But after all, perhaps the strangest left-over of all insular animals is the Solenodon of Cuba and Santo Domingo. There are but the two species known and these two survivors of a remote geological epoch form an order of mammalia by themselves, for there are no other creatures remotely resembling them in all the world today. Here, in a single mammal, we have the characters of rodents, insectivora, and carnivora combined, while, on the San Domingan species, we may see the transition from skin to hair and may learn just how animals first developed hair to cover their naked skins, for the slow evolution from epidermis to wool and hair, which took countless thousands of years to develop, is present on the Solenodon's body. In external appearance the Solenodon is much like a gigantic rat with very short legs and a long flexible snout. The tail is long, scaly and rat-

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like; the proboscis resembles that of an ant-eater; there is practically no neck; the eyes are very small; the forelegs end in huge trowel-like feet resembling those of a mole, and the forward portion of the body is covered with thick, coarse hair which gradually becomes wool, then scales and finally warty skin on the rear parts. In his habits the *Solenodon* is as primitive and out of date as is his structure. He is largely nocturnal and feeds upon a miscellaneous diet of insects, ants, fruit, vegetables, chickens, birds' eggs, reptiles or almost anything that he comes across. He is very slow in motion and his head is so large and his neck so short that it is an impossibility for him to run forward, and, as a result, he sidles along like an awkward crab. He is a very stupid creature, hardly knowing enough to escape when chased, and if pressed too closely he buries his head in leaves or under a rock or stick like a ostrich and imagines he is concealed.

But it is not only among the higher animals such as birds and mammals that we find survivors of prehistoric forms among insular ani-

mals. The gigantic land-tortoises of the Galapagos Islands off the western coast of South America have no living counterparts, and New Zealand boasts of a remarkable lizard which is the only living representative of the prehistoric types. Among the insects and invertebrates which dwell upon islands there are also forms which are known from no other part of the earth save as fossils, and others, which are closely related to species found on continents, are primitive forms of life. In fact, all through the animal kingdom, as represented on islands, we find a very great number of these survivals from ancient times, which may prove either that the islands have been cut off from other lands since prehistoric days or that insular life has a tendency to preserve original forms owing to there being no necessity to evolve new characteristics for protection.

But aside from the species of animals which are peculiar to islands there are many forms of life which prefer islands as their dwelling places and many of which have a very important bearing upon the formation of the

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islands themselves. For example, there are the sea-birds, such as pelicans, gannets, cormorants, terns, gulls, etc., which roost and breed by countless thousands upon many islands.

As these birds have been frequenting the same rocky islets for centuries upon centuries their droppings have accumulated and piled up until many islands are practically composed of manure, or, as it is called, guano, which in time becomes transformed into a solid, rock-like mass. As this material is a splendid fertilizer the guano on these islands is mined and exported, so that the sea-birds not only help to build islands, but render a great service to mankind as well.

In the tropics an important adjunct to islands are the corals, for even where the islands are not of coral formation the coral reefs surrounding them protect the shores and even increase the size of the islands, while the pieces broken from them aid in making the beaches. Wherever there is rocky or hard bottom and shoal water in tropical seas corals grow and flourish, and as they grow upwards they con-

stantly have a tendency to form reefs. For this reason the commoner forms of corals which occur at moderate depths are known as reef corals. There are many kinds of these reef corals, some beautifully branched like trees; others like great bunches of flowers; others flat and spreading like mushrooms; others fan-shaped, and still others domed and resembling gigantic brains. As a rule, these various forms are associated and grow together, and as they are brilliantly colored in life they present a very beautiful sight when viewed through the clear blue waters of the tropical seas. Contrary to popular ideas, corals grow very rapidly under favorable conditions, and if a reef of coral is badly broken or damaged by the waves during a heavy storm the damage is soon replaced with new coral, so that a living barrier is always maintained.

Just as coral islands are formed by broken coral, shells and other material filling in behind them, so the coral reefs that grow off the shores of islands form areas of still water between the reefs and the shores

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which are gradually filled in and become land. But even where the corals do not find conditions suitable for forming reefs they grow abundantly upon the rocky shores of the islands and provide a great protection from the breaking waves for, unlike solid rock, the corals are constantly growing and replacing the masses broken or torn away in storms. Aside from the corals there is also a wealth of other forms of marine life about islands, for, as a rule, the water surrounding islands is far purer and clearer than near a continent, and there is always a lee side where there is protection from waves and storms. In such sheltered spots myriad forms of underwater life thrive and grow upon the rocks, in the sand and on the bottom. In northern seas are oysters, seaweeds, kelp, mussels and shell fish, sea anemones, starfishes and a whole array of lesser creatures, and in the tropics, sponges, gorgeous sea-fans and huge sea-rods, pearl shells and conchs, huge sea-anemones of wondrous hues and two feet or more in diameter, delicately tinted shells, strange naked molluscs, loathesome cuttle-fishes and scarlet and

violet-tinted corallines, for somehow islands seem to hold as great a fascination for the lower animals as for man.



CHAPTER VI

ISLAND VEGETATION

JUST as the animal life of islands near the mainland is, as a whole, similar to that of the nearby shores, so, too, the vegetation is of much the same character as the mainland flora. But the further from the mainland the islands, the more distinctive becomes the plant life, and on many islands there are numerous plants, shrubs and trees which are found in no other part of the world. Many of these are small, inconspicuous and unimportant, but others are of great economic value to the world or are such botanic freaks as to have world-wide fame, for insular plants, like insular animals, appear to revel in developing bizarre forms and incongruous habits. A good example of such is the remarkable "Twin Cocoanut" of the Secheylles Islands. The fruits or nuts, which are strange, double-barrelled affairs like two huge cocoanuts ce-

mented together side by side, have been known for centuries as they are often found floating on the sea, but it is only within comparatively recent years that the palm which produces them has been known to botanists. Formerly, as the nuts were only found at sea and as no one had even seen them growing, it was believed that they were produced beneath the sea, and they were regarded as most mysterious and remarkable things and were looked upon with a vast amount of superstition. The palm which bears these nuts is almost as remarkable as the fruit itself, for it grows but a few feet in height and has the male and female, or staminate and pistillate, flowers on separate trees. The nuts are borne in groups on stout stems like cocoanuts, but so near the ground that they frequently rest upon the earth, giving the tree the appearance of growing from a mound of nuts. Although the nuts float far and wide upon the sea yet, strangely enough, they do not take root and grow wherever cast upon the shores as do the cocoanuts, and the plant, as far as known, is found only in the Secheylles.

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Among the palms are many beautiful and odd forms that are confined to certain islands, and many of the fruits, spices and vegetables of commerce were originally peculiar to one or another of the tropical islands scattered over the oceans near the equator. But, in the case of all cultivated plants, it is almost impossible to determine their place of origin, for through the influence of man or by the elements they have spread far and wide until today they are found upon practically every island suitable to their growth. The cocoanut is typical of this and is a striking feature of every tropical isle, while the bread fruit, the banana, the plantain, the sweet-potato and many other vegetables and fruits are so thoroughly disseminated in tropical lands that no one can say where they originated. But even where there are no conspicuous plants peculiar to an island there is always something distinctive about insular vegetation and, in a way, there is a more or less striking resemblance between the flora of islands throughout the world, be they in the north or in the tropics. The species are dif-

ferent, the families, and even the orders are distinct, and yet, in the low-growing brush near the water's edge, in the thickets beyond, in the trees that grow in the interior, and in the hardy, dwarfed vegetation that covers bare rocks and ledges the insular vegetation of temperate zones finds its counterpart in the ranker growths on tropic islands.

Always there is a certain system, a pre-arranged plan, in the distribution of island plants which has been developed and brought about through Nature's law of the survival of the fittest and the necessity of adaptation to surroundings. But while the system is more or less constant on all islands the plant forms which carry it out vary greatly according to the location of the island and its formation. Thus, on an island in a northern lake we will find the beaches backed by a fringe of low shrubbery composed of thorny brambles, thick hazel bushes, water-oak, elder bushes, various vines, witch-hazel, high-bush blueberry, blackberry, alders, etc., while, in the shallows and coves, are nodding cattails, coarse grasses and reeds and lily-pads, sheltered by over-

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hanging willows and silver birches. Here, alders and other bushes grow from the shoal water and form a thicket of stems which serve to break the tiny wavelets of a summer's day or the heavier seas of a September's gale, and form a smooth, secluded space beyond, wherein the herons lurk, the ducks find safe refuge, the redwings pipe and the marsh wrens gurgle, while turtles sun themselves on jutting snags or exposed boulders.

Back of the fringe of shrubbery which forms a wind-break all about the shores, are thickets of maple, birch and oak mingled with hemlock, spruce and pine, while, further inland, rise the hardwoods and the evergreens of the forest. Upon the bare, exposed ledges where trees cannot find roothold, grow dull-gray lichens, reindeer-moss, dwarfed grasses and low flowering plants, with dense, impenetrable masses of juniper, blueberry and bayberry bushes wherever a thin layer of earth or vegetable mold or a crevice affords them opportunity to gain a footing. All this may vary slightly; we may find the conifers growing to the water's edge with scarce a hard-

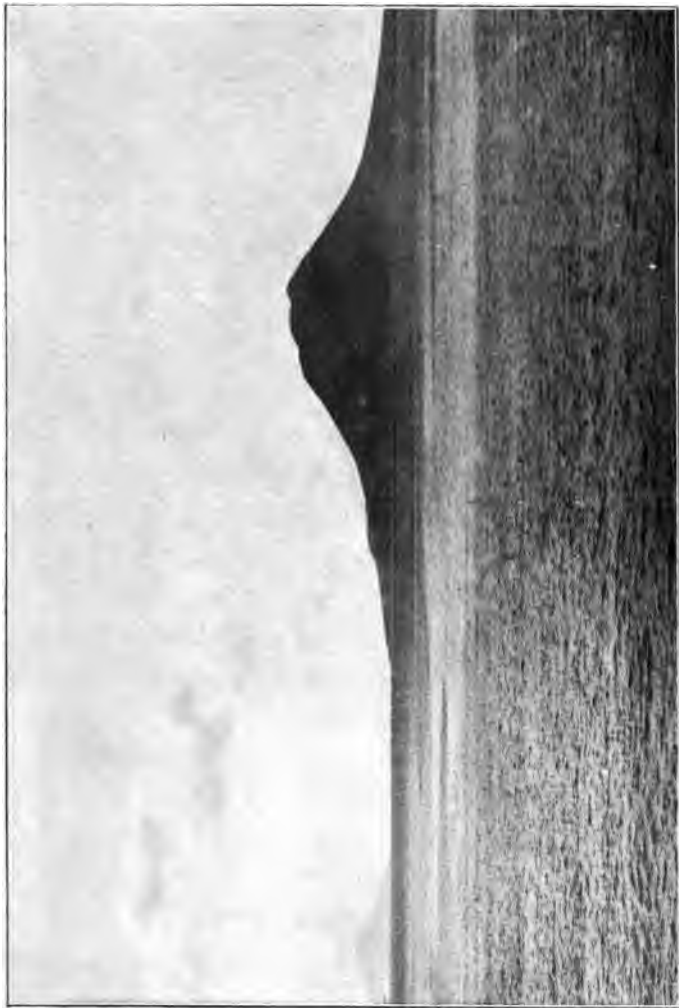
wood tree, or we may find no evergreens, but save where the rocky shores are abrupt or bare there will be some trace of the barrier fringe of shrubbery; in coves and bays where the water is shoal will be the breakwater of grass and reeds and bushes, and on the rocks will be the hardy, stunted lichens, moss and shrubs.

But of course there are islands, either of sand incapable of supporting vegetation, or of rock so bare and exposed that only wind-bent, stunted cedars represent the trees and whose shores have no protecting wind and wave-breaking vegetation, and such we will pass by. If, on the other hand, our northern island is off the seacoast we find the vegetation somewhat different, but the system or arrangement very similar. The cattails are replaced by tough, reed-like watergrass, the alders, hazel, and willows are replaced by gnarled and twisted basswood, bayberry and wild-rose bushes, bound and lashed into a veritable wall with woodbine, poison-ivy and seaside morning-glory. The silver-birches and maples are represented by basswood and

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sassafras and red cedars, stunted, scarred, gnarled and battered from countless winter gales and summer storms, by sleet and salt and spray, while, if the islet be of any size, pines and other evergreens and hardwood trees will rear themselves above the lower growths in the interior of the island and, on the bare ledges, will be the counterparts of the rock-loving plants we noted on the lake island: the same gray lichens and reindeer-moss, the same dwarfed grasses, the same jungles of bayberry, sumach, juniper and blueberry, with here and there masses of spiny, prickly-pear cactus and draperies of poison ivy and of woodbine.

It is a far cry from an islet in a northern lake to an island in some jungle-bounded lake under the equator, and yet the vegetation follows the same system and, save for the difference between tropical and temperate zone plant forms, is very similar. Above the shelving beach is the brushy barrier, but instead of the familiar northern shrubs are thorny bushes covered with terrible spines; mimosas armed to tear through flesh and garments,



A VOLCANIC ISLAND (ST. EUSTATIUS.)

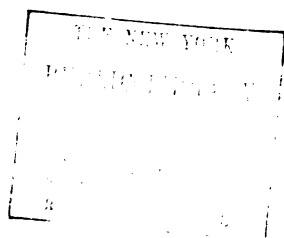


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TREES ON A FLOATING ISLAND

**Showing how the roots spread above ground and bind the fallen
leaves and dead trees together**



glossy-leaved mangoneel with its poisonous, apple-like fruits, wire-like vines and razor-edged sawgrass. In the shallows grow grasses and cattails as in the north; the lily pads are those gigantic platter-like leaves of the *Victoria Regia*, and the wave-breaking tangle of stems is of mangrove and not of alder, with giant, lily-like "Muka-Muka" replacing the pickerel-weed and flags. Where willows droop their graceful branches in the north are huge feather-like clumps of bamboo; in place of birch and maple are slender, plume-topped palms; the evergreens are missing and the lofty hardwood trees are draped and bound together by trailing vines and lianas, while, upon the bare rocks, grow various forms of cacti, needle-leaved agaves, strange sensitive plants and gray lichens which might have come from the ledges of our northern island. And if our tropic isle be surrounded by equatorial seas we will find the arrangement of vegetation and the characters of the plants vaguely familiar. To be sure, the wind-beaten basswood, bayberry and cedars will be missing, but the twisted, misshapen, sea-grape

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trees, the fine-leaved mimosas, the broad-leaved sea-beans and the mangoneel take their places, and in the convolvulus vines that bind the whole together we recognize the tropical form of our wild morning-glory. In the coves, mangroves serve in place of the wave-breaking, land-building sea-grass; graceful cocoanut palms wave their crowns and clash their huge fronds far above reach of salt spray or breaking waves, and the forest trees of the sheltered interior are all new to our eyes; but all are as well fitted for their insular existence as the familiar, island-loving trees of the north.

And now, having learned something of the formation and origin of islands, having classified them and having dwelt briefly on their characteristics, their resemblances, their differences and their animal and vegetable life, let us, in imagination, make an island tour and, visiting islands typical of various kinds, see what additional knowledge of interest we can acquire through observation.

CHAPTER VII

A RAMBLE ON A LAKE ISLAND

UPON the placid bosom of the lake the little island rests, its rocky ledges, its soft, green shrubbery and its dark crown of evergreens mirrored in every detail upon the burnished silver of the water. As we approach closer, we note that the water shoals and, with our canoe resting motionless, we gaze through the clear liquid and scan the bottom of the lake spread out beneath us. Scattered upon the sand are numerous dark-brown and black mussels, their pearl-lined shells slightly opened and the cream-pink flesh between them visible. All about lie other mussels, dead and opened, and with their pearly, lustrous interiors flashing back the sunlight streaming through the water. You wonder what destroyed them, but you will find the explanation later when you land on yonder beach. Waving gently to and fro above the mussels

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jutting log, half-buried in the sand, is a pile of opened mussel shells and, leading from them to the water's edge, a well-marked track of numerous little feet. Here is the explanation of the mussel mystery: a muskrat's breakfast table, and if we visited the island in winter we would find the dome-shaped winter homes of the creatures dotting the ice all about the island. All along the little strip of sand are scattered odds and ends carried here by the wind and waves and an examination of this debris will give us a keener insight of the animal and plant life of our surroundings. There are the bleached shells of a dozen or more species of fresh-water shells; little fragments of fresh-water bryozoans and sponges; dried, fresh-water weeds; bits of fishes' skeletons; thousands of seeds of forest trees and shrubs and countless cones of pines and firs and other coniferous trees, and, if we look closely, we will find hundreds of insects: moths, butterflies, beetles, and representatives of every order of insects, all dead and dried, victims of their attempts to make the long flight across the waters. A hodge-podge of

flotsam this little beach, in truth; but it serves a purpose in illustrating how many of the island's plants and animals first found a foothold on the bit of land in the middle of the lake.

Stepping across the beach with its story written in the dead and stranded remains of animal and plant life, we push our way through the tangled shrubbery that bounds the narrow strip of gravel. At first sight it appears to be a uniform mass of alder and briers, but, if we look closely, we will find that a score or more of plants go to make up the whole. In addition to the alders, are rough-leaved hazel bushes; witch hazel; elders with their sweet, white blooms alive with tiny insects, buzzing bees and odd, blue, longhorn-beetles; high-bush blueberries with their masses of pink, bell-shaped blossoms or luscious berries; maples and maple-leaved viburnum; moose-wood and arrow-wood with scarlet stems; hornbeam and scrub oak; blackberry vines and wild roses and a dozen others; while, to make the tangle more complete, are bitter-sweet and wild-grape vines; smilax and clematis; wood-

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vine and poison-ivy. But it is a thin barrier and, breaking through, we find ourselves in a more open area with slender birches and maples, poplars and aspens, a few basswoods and oaks, and perhaps many elms. Underfoot, the ground is gay with touch-me-nots, blue violets or golden-rod and asters, according to the season, while, beyond and towards the center of the island, we look through aisles of beech and birch and evergreens. Where we stand, the earth is dry and firm, but, turning to one side, we push forward through knee-high weeds and make our way towards a thicket where white-birch trunks gleam in the shadows. Soon the ground becomes damp and soft; the broad, green leaves of skunk-cabbage and Indian-poke appear, brilliant cardinal-flowers and blue gentians add a touch of dazzling color here and there and, presently, we give an involuntary start as a huge frog leaps from beneath our feet and with a loud "kerchunk!" plumps into the water among the alder stems.

Beyond the alders stretches the smooth water of a little cove, hidden and cut off from the

lake by tufts of sedge and grass, waving cattails and blue-flowered flag, and with the water-loving bushes straggling out from either shore until only a narrow strip of open water connects the cove with the lake beyond. Upon the surface of the cove gleam yellow and white pond-lilies with their round, flat, leaves like a pink and green carpet upon the water, while, at our approach, the croak of frogs ceases abruptly, a score of turtles flop into the water from their sunning place on a log and a brace of lovely wood-ducks whirr, with startling suddenness, from among the lilies. All about us are white birches and willows, water-elms and swamp-maples. From an alder top an epauletted redwing pipes his simple notes; a marsh-wren balances himself with jerking tail upon a cattail and pours forth his rollicking song; a gray-coated catbird "meows" inquisitively from the thicket; song-sparrows flit like shadows among the brambles; a downy woodpecker beats a tattoo on a dead birch stub, and from the evergreens issues the piercing cry of a bluejay. Turning our steps inland we leave the soft,

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marshy edges of the cove behind; the white birches give way to beech and oak and, as we ascend a gentle slope we enter a forest of conifers with clumps of mountain-laurel scattered here and there. The little island seems to swarm with life and at every step we see or hear some bird or mammal. Somewhere a hermit-thrush sings sadly sweet; flocks of warblers twitter in the tree-tops; a red-eyed vireo calls plaintively; chickadees are busily searching for hidden insects all about us; a red squirrel scolds at us from his refuge in a hemlock; a dainty, striped chipmunk darts like a streak of light along a fallen pine and dodges into his hole, only to pop up again the next second and stare at us impudently. Then a grouse whirrs from cover among the laurels; a sentry crow takes up the alarm and caws raucous warnings, so that all may hear and scolding bluejays join their shrill cries to the uproar.

As we ascend, the soil becomes drier and thinner; the pines and hemlocks give way to cedars; the laurel disappears and whortleberry bushes, junipers, and odorous bayberry

and red-berried sumachs takes its place, and, brushing through these, we come upon a broad, smooth ledge of granite marking the island's summit and affording a sublime view of the little isle and the surrounding lake with its encircling hills and mountains. Upon the rock are patches of clinging, gray lichens; in slightly hollow spots are dense areas of brittle, greenish-gray reindeer-moss; from crevices in the rock, mountain saxifrage and blue-eyed grass sprout up and aquilegias droop their crimson flowers. Glancing more closely at the rock on which we stand we notice, for the first time, deep, parallel grooves running across the surface and recognize them as the work of glaciers, and, as further proof that the island was once buried beneath countless feet of solid, moving ice, we turn to a huge, rounded boulder balanced precariously upon the sloping ledge where it was dropped when the glacier melted and poured the waters from its dissolution into the basin which now is the lake about our island.

Perchance the island is not entirely of the hard granite which forms the ledge on

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which the glaciers have grooved their story. If we circle the island in our canoe and examine the exposed cliffs that rise steeply from the water beyond the beach, we may be surprised to find them composed of very different rock. Instead of being worn smooth and rounded by the elements, this material is cut and carved into flat sheets, piled horizontally one upon another or, again, it may take the form of knobs and sharp pinnacles or fantastic shapes whose profiles resemble giants' features. If we examine this rock closely we will find it much softer than the granite, and, instead of being composed of crystals of feldspar, mica quartz and hornblende or tourmaline, it is built up of countless tiny grains of sand cemented together exactly as if a sea beach had been suddenly hardened into rock. And this is precisely what it is—a sandstone which, millions of years ago, was a sandy beach, and if we find a spot where the rock has broken away and the slab-like layers have fallen apart, we may be rewarded by discovering some most interesting things. First, we note that when we strike this stone it does not break

into sharp-edged, irregular pieces as does granite, but splits into flakes or flat pieces like slate, and we find that, in many cases, each of these sections is different from the next. One will be of grains so fine as to be scarcely distinguishable with the naked eye; another will be made of coarse grains of sand mixed with small pebbles; some are dark brown or almost black, while others are yellowish or reddish, for the ancient beach was not transformed to sandstone in a day, but required countless ages for the process, and, during all those years, tides and waves and freshets were constantly depositing additional layers of sand upon the beach. A heavy storm would scour and wash the coarser sand from below the waves and cast it upon the shelving beach; a very high tide in calm weather would deposit a film of mud and silt upon the sand beneath; a river, swollen with heavy rains, would bring tons of fine sand in its flood, and as its current was checked by the incoming tide at its mouth its burden of sand would sink and find lodgment on the beach and, through the centuries, this would go on until, at last, the beach be-



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ing made therefrom, for wherever an imprint was made upon that ancient beach the silt or sand deposited upon it later filled each tiniest indentation and made as perfect a cast as could be produced by human hands with plaster.

Perhaps you wonder how it is that if this sandstone cliff was once a beach it is now many feet above the water. There are two ways in which this might have occurred. Perhaps, since the long-distant days when Nature was transforming this beach to stone, the surrounding country has been worn down and cut away until the harder sandstone has been left standing above the present level of the water, or, on the other hand, maybe during the ages which have passed, some stress or disturbance of the earth's crust has pushed this area upwards and has raised the fossil beach many feet above its original level. Perhaps, if we search carefully and note the surroundings, we may be able to say definitely which of the two is the correct solution of the puzzle. Yes, here is the answer! Here on the walls of this deeply-cut cleft in the rock we can see that the layers of sandstone are sharply tilted at an

angle and are even bent and broken as though some irresistible power had heaved upwards from below. And what is this? Joining the shattered layer of sandstone and cutting it off in the abrupt, almost perpendicular line, is a mass of granite, and we know that another page of the island's story has been opened for us to read. Here where we stand upon the quiet island in the lake was once a scene of awful turmoil and inconceivable chaos; the battle-ground of Nature's mightiest forces. Up from the molten interior of the earth an incandescent mass of plastic rock was forced and, reaching the friable sandstone and finding a weak spot, the white-hot flood pushed its way through the yielding layers of sandstone, tearing off and lifting on its crest thousands of tons of the fossil beach, ripping through the alternate layers; bending the edges upward; tipping the whole vast mass and, at last, cooling and hardening and crystalizing into granite and forming a vast dyke or intrusion of hard rock extending for miles and miles through the sandstone formation. Then, through the ages following, the mass of sand-

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stone lifted on the summit of the dyke—and much of that on either side—was worn and cut and decomposed and washed away by rain and wind and frost, leaving the hard, resisting granite standing far above the surrounding country in the form of hills and mountains and islands, with only a fragment of the sandstone clinging to its sides to tell us the marvelous story of the island's past.

Perchance, however, the island which we visit may be of limestone instead of granite and sandstone. In that case, while we will miss much of interest we will find many other interesting things to make up for our loss. If we examine the soft, gray limestone we will find that, instead of being composed of grains of sand or crystals, like the granite and sandstone, the rock consists of a fine-grained, compact mass filled with innumerable shells and marine growths. Tiny, scallop-like bivalves; spiral snails and clam-like shells are everywhere; here and there a circular object with radiating lines from its center to its edges marks a bit of coral; a jointed, stick-like bit, like a tiny bamboo, is the stem of a crinoid;

lacy, fern-shaped bryozoans and countless forms unlike anything we have ever seen are all jumbled and pressed together as if a mass of shell-filled mud-flat had been stirred up and then placed in some titanic press and squeezed until hard and compact. And this is what, in effect, has actually occurred for, just as the sandstone was once a beach built up by tides and waves and floods and transformed to everlasting rock, so this limestone was once the bottom of a sea which—with all the skeletons and shells of marine animals which died and left their remains in the mud beneath the waves—has been transformed to another kind of rock. And just as we found the sandstone had been lifted up and had been cut by molten, igneous rock, so, too, we may find that the same has happened to the limestone, or, on the other hand, the surrounding country may have been worn away to leave masses of the limestone standing.

As limestone is soft and easily cut by the elements and by flowing water it is often worn into caves and grottoes and, if we search carefully on our island, we may discover deep,

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dark caverns wherein, throughout the summer months, the snow and ice of winter are preserved as in a huge ice-chest, or we may find caves hung with stalactites and with conical stalagmites rising from its floors while the crystalline, white limestone, deposited by seeping water upon its walls and roof, gleams in the light of our torch like myriads of precious stones and transforms the spot into a veritable Aladdin's cave.

But interesting and fascinating as it all is, we tire at last of the lovely island in the lake and long for new islands to explore, so let us travel to the seaside and cross a stretch of sparkling, white-capped waves to an island of quite a different sort a few miles off the coast.

CHAPTER VIII

AN ISLAND IN THE SEA

AS we near our ocean-girt island we note that, from the breaking waves, a smooth expanse of rock stretches for some distance to the greenery of vegetation, that many of the higher rocks and cliffs are deeply undercut and that masses have fallen from above and lie in confused heaps with the sea foaming and washing among them, while in one spot, an out-jutting, rocky point has been cut through and forms an arch of stone. Near this, a tiny rocky islet rises from the waves a few rods from the main island and we can see that a little more beating of the sea against the natural arch would sever it from its outer support and thus form another pinnacle-like islet. Now we are close to shore and, from the cliffs and rocks, great flocks of seabirds rise with a din of harsh cries. Everywhere that there is a crevice or a tiny shelf or rock, the cliffs swarm

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red masses of sponge, yellow and white-branched sponges, countless delicately formed bryozoans and wonderfully dainty hydroids. Shells there are by hundreds; unattractive, black winkles; polished yellow and brown neritas, tiny white clam-like bivalves, rough oyster shells, heavy shells of quohog clams, lovely pectens, fluted scallops, spiral drills, and scores of others, great and small. Dead crabs there are, too, and many a cast-off shell of lobster, crab and shrimp with, here and there, a starfish, a sea-urchin or a dried and shrivelled fish, while everywhere are the remains of insects just as among the flotsam on the lake island. But just as the sea is far richer in life than fresh water, so this ocean island's beach bears a far greater variety of animal life than the little beach of the island in the lake.

Leaving the spot at last we approach the shrubbery that borders the beach and find it very different from the vegetable barrier on the other island we visited. We look in vain for the alders, the hazel, the viburnum, the maples and the other bushes that we found

upon the lake island. Instead, we find tough, gray, bayberry bushes, stunted and gnarled bass-wood, thickset wild roses, bunches of juniper, dense masses of poison-ivy and wood-vine, tangled beach-peas and coarse morning-glory vines. Here and there a wind-beaten, spray-browned cedar tree gives a touch of different color and clumps of coarse, wiry grass grow scattered at the edge of the beach. Beyond the thicket is a miniature jungle of bayberry and cedar, poison-ivy and woodvine, dense whortleberry bush and sumach, with battered trees of basswood, sassafras and hickory, all showing in their knobbed and bent trunks, their twisted branches and their tattered, scant foliage the marks of battles with driving sleet and spray, with whipping winds and pelting rain, with loads of ice and snow, for summer and winter for years and years, they have withstood the fury of the elements and, wounded and scarred as they are, have held their own upon this sea-girt island of the north. And aside from this, they have served a useful purpose in protecting the less hardy trees and plants beyond—the whisper-

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ing pines, the conical red cedars, the red-oaks and the larger basswoods. Soon the tall but impenetrable bushes open out and areas of sparse grass appear with broad spreading clumps of juniper and with golden-flowered dandelions, yellow-eyed grass, thistles and a few other flowering weeds giving a touch of color.

From a juniper, as we brush past, a song sparrow flits and in the center of the prickly mass we find her nest of grass and roots with its speckled eggs of green and brown. Upon the weeds and thistles black-winged goldfinches swing and feed; we find the neat cup-shaped nest of a warbler in a crotch of a sassafras and a purple finch warbles a medley of music from the summit of a pine. Catbirds glide like shadows in the tangled shrubbery; a kingbird darts from his perch in chase of a passing butterfly; a wood-phoebe utters his plaintive call from a basswood and a spotted sandpiper flutters from its nest in the short grass and, simulating a broken wing, strives to lure us away from her treasures: four spotted eggs so like the granite

pebbles strewn about that one might search for hours without finding them did not the mother attract our attention. As we wander on, field-mice and meadow voles—distant cousins of the muskrat—scamper through their runways in the coarse grass, and we even catch a fleeting glimpse of a sleek, brown mink as, with lightning speed, he darts into a tangle.

We are now among the larger growth of the island; pitch-pines and cedars with a few hickorys and basswoods that show evidences of a hard struggle for existence, but all so scattered, either singly or in groups of three or four, as not to form a forest and with much of the earth beneath them covered with bayberry and whortleberry bushes over which poison-ivy and woodvine clamber riotously. Presently we come to a swampy hollow where elders grow and the sky-blue flags nod above the tangle of rank weeds and grasses and masses of white clematis drape the bushes, and from the little slime-covered pool in the centre a black duck springs upward on whistling wings. Continuing on our way we turn

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towards higher land and come to a wide expanse of bare ledges and find the cracks and crevices and every little pocket of earth filled with the same plants as those upon the rocky heights of our island in the lake. Here are the same bayberry and whortleberry bushes; the same stunted cedars; the same gray lichens and reindeer moss, while, sprawling over the rock and growing in formidable bunches in the crevices are thick-leaved, prickly-pear cactus with pale yellow, rose-like blooms.

And here again, as upon the other island, we find the deep scored marks of glaciers and know that even here the mighty cap of ice once extended. From here the ledges stretch, bare and unbroken, to the sea and, wandering across them, we come to the weed-covered, kelp-draped rocks left exposed by the retreating tide. Between the rocks and in the wave-worn hollows of the ledge are many tide-pools of clear water, and here let us linger a space, for each of these pools is a natural salt-water aquarium. Everywhere upon the rocks grow the barnacles with young oysters and masses of black and blue mussels among them. Little

shrimps shoot out of sight as our shadows fall across the pool; a few small crabs run nimbly over the barnacles and slow-moving hermits, with their shell homes upon their backs, crawl clumsily hither and thither apparently wandering aimlessly. A few small fish—camouflaged by Nature as effectively as the terns' and sandpipers' eggs—rest almost motionless upon the pool's bottom; a purple-hued starfish clings to the rock and feels blindly about for a new hold for his suckers; numerous winkles and other shells rest or move about upon the rocks, and from hidden holes and crevices brilliant scarlet and yellow, feather-like tentacles of marine worms wave slowly back and forth. Hidden under a projecting ledge are many sea anemones, dull-brown or green or flesh-colored, with their flower-like tentacles expanded, while innumerable vividly-tinted seaweeds and hydroids sprout from rocks and mussels and barnacles like a liliputian forest of many hues.

Life is everywhere, for even on the very barest and water-worn rocks metallic-backed tiger-beetles alight with jerkily lift-



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ing wings, alert and ready for instant flight; in the air terns and sea gulls wheel above the waves and swift-winged swallows skim the bushes; a soaring osprey circles overhead; a belted kingfisher darts by with his discordant rattle; a school of porpoises are disporting themselves a few rods off the shore, and pattering daintily over the black-brown seaweed at the water's edge are slender-legged sandpipers and ring-necked plover. And even yonder uninviting expanse of black, tenacious mud between those rocky points is the home of living creatures. Should we dig into it we would find countless clams, innumerable iridescent-colored annelids, spiny sea-cucumbers, small serpent-starfish, odd crustaceans, mud-crabs and several species of shells. And as we retrace our steps across the little island we realize how perfectly old Mother Nature has planned it all; how she has provided for the rocks eaten off by the waves to form a breakwater about the cliffs; how she has provided a living place for each and every form of life, however small, which makes the island its home; how she has adapted all these

creatures and even the vegetation to an insular life; how she has wrought a living barrier of storm-resisting plants into a wall to protect the shallow soil and the large better growth from sea and spray, and how, through the inexorable law of the survival of the fittest, the weak and useless plants unfitted for the hard life of the island have been eliminated until only those remain which can withstand the fiercest onslaught of the northern ocean's storms.

But now we will travel far from these two islands of our stern northern latitude and visit some islands that bask neath the sun of the tropics.

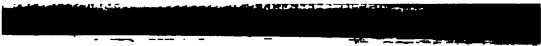


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bark. Ahead of our slowly moving boat, queer fresh-water flying-fish skitter away like tiny hydroplanes and strange "four-eyed fishes," with their protruding eyes above the water, dash madly off in every direction. Above us tower the mighty trees, but there is no spot to land, for under the overhanging branches and filling the spaces between the enormous trunks is an impenetrable jungle of spiny palms and thorny brush and tangled razor-grass reaching to the fringe of mangroves with their wide, spreading, cable-like roots drooping from branches, springing from trunks and forming a labyrinth through which no boat may pass. And nearer still, and extending from the mangroves well into the river, is the outer barrier of "Muka-muka" like gigantic, pickerel-weed on ten-foot jointed stalks.

All about us are strange trees and stranger forms of life. From a half submerged log a great alligator slips into the stream; a flock of noisy parroquets sweeps chattering overhead; a pair of gaudy macaws scream at us from a palm top, and in a flower-

ing tree we catch a glimpse of grotesque, enormous-billed toucans hopping about in queer, jerky movements and constantly uttering short yelps like hoarse puppies. From many trees hang enormous yard-long, bean-like pods; from others are suspended great bunches of glaring scarlet or purple berries or brilliant orange fruits, and everywhere are the air-plants and orchids, some like overgrown pineapple-tops, others with immense trowel-shaped leaves a foot across, others bearing marvelous flowers of every shade. Presently we come to a jutting ledge of rock, the boat is run ashore and we disembark. And instantly our eyes are attracted by a strange growth that covers the rock as with a pink carpet, a delicate, fragile-looking plant which seems to spring from the smoothest ledges and about which are hovering countless thousands of brilliant yellow butterflies. But there are so many things to see that we can scarce give a moment's attention to any one. We thought our little island in the northern lake teemed with life, but here in the tropical river, life fairly swarms. A big, yellow-breasted, im-



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pudent tyrant-flycatcher challenges us with his sharp incisive cry of "Kis-ka-dee!" black carrion-hawks screech at us complainingly from the trees, a snowy white heron reluctantly takes wing from the water's edge, scarlet-headed finches flutter about at our very feet, scores of metallic-green swallows flash back and forth about our heads, a brilliant-hued humming bird dashes at us pugnaciously as we examine his tiny nest of moss and spider's web hung to a swaying leaf-tip, and dozens of gray, green and brown lizards scuttle out of sight as we step forward.

Just before us looms the forest with no barrier of brush as upon our northern lake island, for here are no winter storms to require a wind-break to protect the other growths, and rankly, luxuriantly, the trees and weeds and ferns and palms crowd and jostle one another, filling every available inch of space and only giving way where a bare expanse of rock permits of no roothold. But even here, we find a wondrous change from the rock-loving vegetation of the north. Instead of the bayberry, juniper and cedars, are

sprangling wild guava trees with their naked, blotched trunks; bulbous orchids which sprout from the tiniest cracks and flaunt weird flowers above the rock; fleshy-leaved, low-growing plants covered with pink and scarlet and mauve flowers; dainty impossibly-green ferns; a score of forms of cacti; bunches of soft-leaved sensitive plants which quiver and fold up at a touch; bushes with curved, double thorns like miniature buffalo-horns two inches in length. Beware of these! Dwelling within the bases of the thorns are hordes of tiny ants which, at the slightest disturbance of their homes, swarm forth and bite like red-hot needles. But our old friends the lichens are here, gray and green and orange, with here and there a tropical form of reindeer moss with tips dyed scarlet.

And just as bird and vegetable life abound on this tropical island, so it is with insect life. Everywhere we look are the ants, great black solitary creatures hurrying about as if searching for something; big red droughers marching along well-marked paths in a double column, the one moving in one direction with

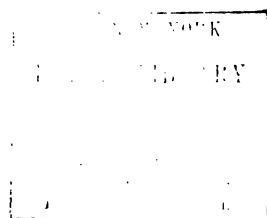
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each individual carrying a triangular bit of leaf above his head, the others moving as steadily the other way and empty-handed, returning from their nests to secure more bits of the leaves on which they cultivate a fungus that serves them as food. Aside from these are countless smaller ants of every size and shade, bright-colored flies, beetles with backs like flashing jewels or burnished metal, dainty little butterflies with mauve or sky-blue wings, larger butterflies of every imaginable hue, and, most glorious of all, the immense, slow-flying *Morphos* with their flashing wings of azure-like sheets of sapphire. And, as we leave the open behind and step into the shadow of the forest, we see the giant owl's-head butterfly, we hear the loud shrill notes of huge katydid-like creatures, and the air drones with a thousand insect notes so blended and interwoven that we cannot separate one from another. Louder still, especially if we visit the isle in early morning or towards evening, are the whistles, trills, booms, rattles and grunts of hundreds of frogs.

All about us rise the huge trunks of forest



ISLANDS IN A TROPICAL RIVER.



trees, towering up without break or branch for near a hundred feet, and with their foliage so far above our heads that we could not recognize them even if we knew them. But a few are distinguishable by their trunks. Here is the smooth, almost polished, red-brown bole of a purple-heart; beyond is the elm-like trunk of a greenheart tree; to one side the yellow-gray trunk of a mora spreads out in twenty-foot slab-like hips or buttresses, while the aromatic, exuding gum of another forest giant tells us we are looking at a gum-ellemi, and the amber-clear resin on another identifies it as a locust.

It is all very interesting, all very strange and new, but there is nothing insular about the growth, nothing particularly characteristic, and as far as our surroundings go we might just as well be in the forest of the mainland. It is the same with the birds, mammal and insect life. Upon a sandy strip of beach on the further side of the island we find the tracks of a big jaguar who has been digging in the sand for river turtles' eggs; a muddy spot at the edge of the mangroves is criss-

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crossed with the footprints of capybara, paca and tapir and we catch a glimpse of a little brocket-deer as he leaps from his bed among the big-leaved caladiums and fades into the shadows of the forest, while in the trees monkeys chatter at us as we pass.

So, unsatisfied, at last we turn to the exposed rocky ledges to see if they can tell us a story as interesting as that revealed by the rocks of our northern islands. At first we are puzzled by the rock; it is not homogeneous granite, nor is it limestone nor sandstone such as we have known. Instead of being made up of numerous crystals of various minerals, or being composed of closely-packed grains of sand or countless fossil shells, we find it consists of a fine-grained, pinkish material filled with rounded pebbles of every imaginable color and looking for all the world as if someone had mixed water-worn stones of a river bed with pink cement. And, in a way, this is what it is, for the rock is a peculiar conglomerate, an ancient river's bed with the fine sand and rounded pebbles hardened into stone, exactly as the prehistoric beach was trans-

formed to the sandstone that we found upon our island in the lake.

As we poke about, examining the rock, we discover deeply-cut grooves which at first we mistake for glacial scratches, but no vast moving sheet of ice covered this tropic island, no glacier carved out the hills and valleys here, and as we examine the grooves more carefully we find them quite different from those made by ice-encased rocks in the north. These in the conglomerate are wider and smoother, they are not straight but curved or wavy, and in them the pebbles of the conglomerate project slightly above the surrounding, fine-grained rock in which they are embedded. Indeed, in many spots we find the little pebbles entirely exposed and apparently merely resting on the rock beneath, but when we strive to pick them up we find they are immovably attached and even when struck with a hammer they splinter to bits before they part from the rock to which they are cemented.

Here and there in the grooves we find small, rounded depressions, as though a huge

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auger had bored into the rock, and, searching further, we find well-like holes several feet in depth and a foot or two in diameter sunk into the ledges. In places these are so close together and, in many spots, the walls between the holes have been broken down and cut away until huge oblong or oval depressions have resulted. In the bottom of every one, either large or small, we find many round or nearly round rocks of hard flinty rock, and in those which are at the river's edge we note that the water whirls around and around.

Here is the explanation, for these are "pot-holes" formed by hard stones moved by eddies of water with a revolving motion and which, through countless centuries, have thus bored and scoured out the holes in the conglomerate. Now we realize that the grooves we took for glacial scratches were also made by hard pebbles and rocks rolled and pushed and ground against the rock by the river's current, while the long, deep troughs and huge, oblong gashes in the rocks are where rows of pot-holes have been drilled and their walls have been cut down by the river exactly

as a carpenter bores a row of holes in wood and then chisels away the intervening material to form a mortise. And if we clear away the vegetation and the earth upon the highest knoll of the island we will find the conglomerate beneath grooved and filled with pot-holes in the same way, for ages ago the river's bed was many feet above its present level and, through the interminable centuries, it has cut deeper and deeper into the conglomerate rock—which in some former period of the earth's history was the bed of a vast prehistoric river—until it has worn down to its present level.

Why, you may ask, has then this little mass of rock which forms the island been spared? Why has not this mid-river hillock of conglomerate been ruthlessly cut away to leave a broad, uninterrupted channel for the river?

There are really several explanations. In the first place, the particular bit of conglomerate of which the island consists may have been harder than the rock about it and hence resisted the grinding to which it was subjected, until the rock about was cut so

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deeply that its surface projected above the water and the river was obliged to recede and abandon its attempt to level the island. Again, a river follows the path of least resistance and flows through the lowest areas of land, and perchance the knoll that now forms the island was slightly higher than the country on either side and thus retained its original relation to the valley which now forms the river's bed.

Once more you may ask why this should have been so. Why should the knoll have been higher than the surrounding rocks?

The answer is simple: we know that the conglomerate was once the pebble-filled bed of some great river and, if we examine any existing river's bed, we will find that it is far from even or level, but is made up of hollows, deep holes and ridges or bars, the hollows corresponding to the currents of the stream and the bars and shallows showing where there is slack water, for the sand and gravel scoured out by the swiftly flowing currents is piled up in heaps where the water is still. And there are many small and trivial things which govern the direction and extent of the currents

and the areas of slack water in a river. A snag or stranded log, a boulder, a slightly harder bit of rock or even a tree or ledge or the character of the river's bank may divert the flow of water and force it to one side or the other or divide it and produce an area of still water, beneath which the sand and pebbles rapidly pile up and still further interrupts the current, which cuts deeper and deeper into its bed. And just as we find these conditions today, so they must have existed in the prehistoric days when the conglomerate formed the bed of a river. Then, through some alteration in the earth's surface, the land was raised slightly, the vast river drained away and disappeared, the empty river bed was transformed to conglomerate rock with all the channels and bars intact, and, centuries later, when a new river sought a way to the sea it followed the ancient channels and wore them deeper and deeper until the mass of conglomerate, which was once a bar of pebbles, was safe from further destruction and rose above the waters as an island. So, just as we know our little lake island was once buried

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beneath a stupendous river of solid ice, so we know that the islet in the tropical stream was once far beneath the swirling, churning, raging torrent of a river so vast that the mighty Amazon would be dwarfed beside it, and just as the resistless mass of the glacier wrote its story in the granite by means of its deeply-scored grooves and the boulders it dropped, so that prehistoric flood of the tropics wrote its story by means of grooves and pot-holes in the conglomerate over which it flowed.

But we have yet other islands to visit, other stories of earth's younger days to read upon the pages of Nature's book spread before us, and, leaving the island in its setting of equatorial jungle, we make our way to the coast and take ship for an island in the tropic sea.

CHAPTER X

A VISIT TO AN ISLAND IN TROPICAL SEAS

How different from the waste of northern waters is the tropic sea over which we travel to reach the island we are to visit. In place of the gray-green sullen water this sea stretches in a vast expanse of deepest ultramarine, the white-caps break in spray in rainbow tints and with marvelous shades of turquoise and azure where the light strikes through the wave-crests. Patches of bright yellow sargassum, or gulf-weed, dot the burnished blue surface and gleaming flying-fish leap from the water and whirr away, like little aeroplanes, to again plunge into the waves in showers of prismatic spray. Overhead arches a sky of purest azure, flecked with snowy trade-clouds, and though the sun blazes down with tropical intensity the air is cool and soft and balmy with the never-ceasing trade-wind. Far ahead above the horizon looms a mass of

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heavy cumulus clouds and, as the ship plunges onward, a hazy, blue mass reveals itself below the clouds which mark the presence of an island.

More and more distinct becomes the distant bit of land; the hazy blue becomes soft green; deep purple shadows appear; we see great pointed mountains with their summits screened by clouds; a slender thread of white marks the breaking surf upon the shores, and presently we make out the shining leaves and slender trunks of cocoa-palms along the beach. The water becomes clearer, paler blue, from shoreward a broad expanse of impossible limpid turquoise flecked with mauve patches stretches towards us, the steamer's engines cease to throb, the anchor thunders over the bows, and, looking over the ship's side, we are amazed to see the bottom far beneath with the great anchor and its length of chain clearly outlined upon the white sand. The vessel seems floating in air, so crystal-clear is the sea, and through the invisible liquid we see schools of brilliantly colored fishes swimming lazily about. We note wav-

ing weeds and great purple fan-shaped gorgonias; black oblong spots upon the bottom are giant sea-cucumbers, and masses of brain-coral look like gigantic oranges scattered about.

And now we glance shoreward. Here indeed is the island we have dreamed of, the isle of romance and of story, the island of Stevenson and Jules Verne, the haunt of wild buccaneer and bloody pirate. Beyond the cream of breaking swell slopes a beach of snowy sand. Above it a double row of cocoa-palms rear their plumed heads; beyond is a belt of dull green and, further inland, stretch low rounded hills and lofty mountains of every shade and tint of green—golden, emerald, malachite, light and medium and dark, from palest jade to almost black, gleaming refulgent in the sunlight; indigo as a passing cloud casts its shadow, and richest purple where ravines and valleys slash the hills. Perchance a little town or village nestles beneath the palms, but it is not there that our interest lies, and, if the isle be uninhabited, we are all the more fortunate, for man undoes much of Nature's most

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fascinating handiwork. So let us imagine no settlement mars the perfection of the scene and no man dwells upon the lovely spot before us.

As we are rowed towards the beach we are fascinated by the multi-colored panorama of the sea-bottom beneath us, and as the boat stops at our request and floats motionless upon the turquoise sea we peer into the depths at the wonderful sea-garden so near and yet so far from reach. Here indeed is a scene which has no counterpart upon the land, a scene of vivid colors and strange forms such as might well have originated in fairyland or in a cubist artist's brain. Huge dome-shaped orange brain-corals cluster in groups and form a low rounded ridge above the sandy floor. Among them stand great branched madre-pores of purple-brown and looking like enormous stag's antlers; swaying among them are inky-black sea-rods, purple and yellow sea-fans, slender wire-like sea-whips, feathery sea-plumes and countless forms of weeds. Here and there irregular masses of vivid scarlet mark the presence of stinging sponges; to one

side stands a cup-sponge of soft brown like a giant's goblet six feet in height; emerald, mauve, lilac, yellow, red and blue rose-corals grow everywhere; immense terra-cotta colored starfish crawl slowly about; huge deep-purple and black sea-urchins nestle amid the corals; giant sea-anemones of every conceivable color spread their gorgeous tentacles like flowers from the crevices among the other growths; the long scarlet and white antennæ of a clawless lobster protrude from his lair; a snake-like spotted moray wriggles aimlessly about; schools of rainbow-tinted fishes of strange shapes flit in and out among the weeds like bright-hued birds in a forest, and a loathsome pot-bellied octopus pulls himself along by his sucker-clad tentacles and changes color like a chameleon as he proceeds.

But the island calls and turning from the sea-gardens we land upon the firm stretch of white sand beneath the palms. And here upon the beach is enough to keep us interested for hours or even days. We examine the sand and find it composed, not of pulverized rock, but of tiny fragments of coral and shells with

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under the cast-up weed and the weed itself are alive with hopping, jumping, flea-like crustaceans which might be identified with those on our ocean island in the north; there are countless shells of various sizes, hues and shapes; many bright-colored crabs scuttle about; we find the same black rubbery skates' and sharks' eggs; masses of dull-ochre egg-cases of snails so similar to those of the north that we cannot see the difference; there are dead and dried starfishes and sea-urchins; we find cast-off crab and lobster shells; sponges of strange forms and delicate texture; bits of gorgonias and sea-fans; corallines of rose and lavender; delicate snowy branched corals; perchance a paper-nautilus or two, with the dead, octopus denizen of the beautiful shell within it, and, everywhere, the iridescent, bubble-like bladders of the Portuguese man-o-war, of which beware, for the long tentacles of these jelly-fish sting the human skin long after the creatures themselves are dead.

But there is one class of animals which is lacking; we find scarcely a trace of insect re-

mains, for this island is so far from shore and the tropic seas are so filled with ravenous creatures that any insects that fall into the water have small chance of being washed upon the island's beach. But there is abundant insect life here. Among the flotsam we find many big earwigs; numerous hurrying black and brown and green ground-bettles; innumerable cockroaches; a few crickets, and many tiny flies. About the flowers of the cocoa-palms over our heads swarm bees and butterflies, and a huge, droning black carpenter-bee buzzes about a dead stump seeking a spot to bore her neat round holes and build her nest, while to a drooping palm-frond is attached an immense paper hornets' nest.

How, then, did insect life come to this mid-ocean island? Perhaps the answer may be found in yonder stranded log which lies upon the beach with masses of vines and air-plants still upon it and apparently uninjured by their long exposure to salt water. No doubt, on such floating bits of forest as this many insects have found their way to the island in years past or, again, perchance, the island was

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cut our way through we surprise many a form of island life. Dainty brown ground-doves flutter up from their feeding grounds; tyrant flycatchers scold at us; a russet-backed thrush, that reminds us of our northern cat-birds, follows at a safe distance as if curious to see who these intruders may be, and numerous checkered butterflies flutter about with a strange clicking sound. Once a big green iguana leaps from a sea-grape tree and plunges into the denser brush, and underfoot innumerable big "soldier-crabs" trundle about carrying their heavy shell-homes upon their backs, while now and then a belated scarlet and purple or livid-blue land-crab scuttles into the six inch holes that riddle the earth.

At last we are through the barrier and find ourselves upon a fairly open space covered with sparse grass, clumps of weeds and pungent-odored sage-bushes. Just beyond flows a shallow stream with fifty-foot bunches of bamboos along its banks, drooping like our northern willows over the swiftly flowing waters. Beyond the stream a low cliff rises, and, crossing over on the water-worn stones,

we reach the foot of the cliff. At first glance it appears to be of black stone, but a closer inspection reveals the fact that the black is merely a coating of dusky lichens and that beneath the material is chalky white and soft, and then we discover that it is not rock at all, but a solid mass of coral! We can trace the outlines of big brain-corals, here and there is a branch of stag-horn coral; there are star corals and rose corals, corals of every shape, and in and between the larger masses are packed innumerable bits of broken coral and shells, the whole cemented into a uniform mass of soft limestone, for the cliff is merely a fossil coral-reef which, through an uprising of the earth's crust, has been raised many feet above the sea. Atop this cliff are palms and hardwood trees; vast quantities of vines and creepers drape their greenery across it, and wherever there is a crack or crevice flowering weeds or delicate ferns have found a foothold.

But it is a hard climb to reach the top and so, taking an easier route, we follow along the river's bank towards the interior of the island. And as we proceed we note new forms of life

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and vegetation. Tiny sable-clad grassquits shrill their insect-like notes from grass stems and weed-tops or perch defiantly upon their neat globular nests in the low bushes; soft-hued doves coo from the bamboos; a gaudy palm-tanager flits across the stream and we see numerous flashing humming birds darting about the flowers. Standing motionless in the water are blue and white herons; an immense kingfisher plunges from his perch into the river to seize a fish; and swallows, martins and swifts skim back and forth above us. Myriads of butterflies are ever in sight; we flush huge grasshoppers from under foot; a huge, hairy tarantula rears itself pugnaciously and then beats a hurried retreat, and lizards of various sizes scuttle away on every hand. But we see no sign of mammal, no creatures bearing hair or fur, for the only mammals on the island are nocturnal opossums and shy forest-dwelling agoutis.

Presently we find that we are in a deep valley with wooded hills on either hand, and soon we are ascending towards the mountains, clambering over rocks and boulders and

skirting high cliffs through which the river has cut its way. As we stop to rest for a space, we note that these rocks are not of coral but are of hard, black, flint-like stone and that the cliffs are not upraised coral-reefs, but are made of a soft, soapy, yellowish or brownish substance filled with irregularly shaped rocks and boulders of every size and, in general appearance, reminding us of an exaggerated conglomerate. But aside from superficial appearance, there is no resemblance between these masses and the conglomerate we found upon the island in the river, for these cliffs are composed of the material thrown out from some mighty volcano ages ago. The softer material is ash and mud, the hard rocks lava-bombs, and the black rocks in the stream are all of lava. Perhaps, if we search carefully, we may find a spot where this volcanic material flowed over the ancient coral formation and, like as not, we may even discover places where there are alternate layers of coral and volcanic debris, for this island has literally had its ups and downs and at times has been a thousand feet or more below the sea, while at

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other times it has been as many feet higher than at present.

We will find it a long, hard climb up through the "highbush" of the mountains to that distant conical peak with the cloud wreath about its summit, and little would be added to our knowledge of islands if we reached it, for while the peak is a volcano it has been asleep or "dead" for hundreds of years and the once-fiery crater is now filled with a quiet fresh-water lake surrounded by a heavy forest. But nearer at hand and gleaming through the intervening foliage is a splendid waterfall, and by following the river we may reach it easily. Before we come to it, however, we enter the forest of the island, a forest in some ways like that of the river island and yet different.

Here indeed are the same mighty trees with their tops interlaced and forming an impenetrable canopy a hundred feet above our heads; here are the same twisted, braided, knotted, rope-like lianas, some as fine as thread, others larger than ships' cables; but many of the trees are different; many of those

of the river isle are missing and, save along the river's edge, the ground is almost bare of undergrowth. Here we find many forms of vegetation which we have never seen before, and with good reason, for they are found only on this and neighboring islands. Prominent among them is the "blue fern," a coarse, bracken-like fern which, instead of being green, is a marvelous glaucous-blue. Clinging to a fallen mass of rock is a dainty fern with the underside of its fronds golden yellow, while, beside it, is another in which the yellow is replaced with silver-white. Place one of these leaves upon your dark coat and strike it sharply and, when removed, you will find the leaf imprinted on the cloth in gold or silver. Nodding from a fern-draped bank is a mass of sweet-scented, pink-flowered begonias; a dwarf, yellow-flowered iris attracts us and we are fascinated by the marvelous variety of velvet-leaved begonias and the intricate, lace-like climbing ferns and fern-like mosses on the tree trunks. And, novel to our eyes, are the giant tree-ferns with their thirty-foot hairy trunks and their forty-foot fronds

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through which one gazes up at the sky as through a canopy of finest lace.

The animal life is very different from that of the river island. No chattering monkeys break the silence which broods over this forest; no screeching macaws or shrill-voiced parrots or clattering toucans. Far above the forest a little group of parrots wing their way from one mountain side to another, and were we able to examine them we would find them very different from any parrots we have ever seen. Large as macaws, heavily built and with deep-green backs and purple breasts, they are beautiful birds, but found nowhere else in all the world save on this island. We listen to catch some sound of life and the far-away mournful note of a big white-headed pigeon is borne to us. Then a garnet-throated humming-bird darts down and twitters almost inaudibly as it hovers about the scarlet and yellow wild-plantain flowers. A wren perches upon a moss-covered rock and trills forth a song so rich and full and musical that only the nightingale can equal it and, from a dark, hidden glen comes the sad but inexpressibly

sweet flute-like notes of a solitaire. All these are island species found nowhere else, and if we spend enough time here we would find two score and more of birds whose only home is on this island.

Even the insects here are entirely distinct from those of the river island and the mainland. We see no flashing blue morphos, no owl's-head butterflies, no drougher-ants. What butterflies we note are mainly dull-colored and inconspicuous, but great white, ghostly moths flit in the shadows; equally huge black moths flutter from trees and rocks where they have been resting, and poking with our machetes in a dead and rotten log we find several gigantic beetles with six-inch, branching, horn-like protuberances sprouting from their thorax. We see many lizards and we find the stream is full of fish, but if we carried specimens of these to naturalists they would tell us all were species peculiar to the island. And when we know this we begin to realize that we are standing on a little world by itself, that plant and bird and insect and reptile are a very part of the island, as much a part

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of it as the rocks and streams and volcanoes.

There is still much to be seen, many places to visit on this isle, and interesting and pleasant as it is within the shadowy forest beside the plunging cataract, we will retrace our steps to the beach. Several miles to the south we see beetling cliffs rising from the sea, and, embarking in our boat, we skirt the shore and head for the cliffs. Soon the beach is left behind and we pass close to an outjutting point with the waves beating upon a steep stretch of shingle composed of coarse, rounded stones. Were we to examine them we would find them all of volcanic formation and in the face of the hill that stretches inland from the point we see their origin, for the hill is an ancient mud-flow from the volcano and filled with laval bombs and boulders, and the sea, cutting into its outer end, has gradually washed away the softer ash and tufa to let the harder rocks drop free and pile as shingle on the shore. And from here, as we look upon the green hills of the island, we can trace the ancient craters and the sharp-topped ridges of lava and ash which flowed from them, for

while all are now softened and covered by the forest, yet their forms remain, like a relief-map painted green.

Beyond the point we come to the cliffs and find beneath them the sea filled with great blocks of stone, sharp-edged ledges, submerged reefs and projecting points of rock among which is a labyrinth of channels and pools of crystal-clear water. Everywhere we look through the water we find the bottom, the rocks, the reefs, all covered with corals, sea-fans, sponges, weeds, gorgonias and other marine growths a hundred times more wonderful, a thousand times as numerous as on the sandy bottom where we first saw our first sea-garden.

In the cliffs above us are countless holes, out and in of which long-tailed, salmon-breasted tropic-birds are passing, but the world of life about the rocks holds more attractions for us than the graceful birds above. Sharp as needles are the little points and pinacles, keen as razors are the ridges into which the rocks have been worn by the sea, and everywhere below high-water mark we find

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the rocks riddled with neat round holes of various sizes and in many of which purple-brown sea-urchins and delicate white bivalve shells are resting. Doubtless you think these are pot-holes worn by the sea and you wonder that the sea-urchins and shells are not ground to bits as the water swirls in the holes. But in your surmise you are wrong for these are not pot-holes and the urchins and shells are snugly at home within them, for while it seems incredible, the fact remains that the holes actually are bored in the solid rock by these creatures themselves. In places the holes are so numerous and so close together that the waves have broken down the stone between them and large blocks and masses of rocks have been released, just as a stone-cutter drills a number of holes in a block of marble or granite and then, by a blow or a wedge, breaks the stone in twain.

Here, then, we have a most marvelous factor in the destruction of the rocky shores of the island, the work of tiny, apparently feeble creatures who are yet able to chisel and bore and cut away the hard rock. And as we

wonder at this we look more closely at the rock itself to determine what sort of material it is which can thus be riddled by these marine animals. Here, too, another surprise awaits us, for instead of granite or sandstone or lava or coral, we find this rock is a solidified mass of tiny, broken bits of shells with fragments of coral scattered through it; a limestone as hard as flint upon the surface, but so soft that we can cut it with a knife or machete where the interior is freshly exposed. Perchance you think that once this rock was a sea-beach which was transformed to stone, like the sandstone of the lake island, but this is not the case, for this rock of shell fragments was formed from drifting sand whipped up by the wind from some shell-beach and piled into dunes or hills, and for this reason the rock is known as Aeolian limestone.

If we now examine the cliffs beyond we will be able to trace the layers of sand of various textures deposited by the gales of long ago, and where the cliff is sheltered from the sea and a gulley has been cut through it by the rain we find layers of loose free sand.

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between strata of the rock where, for some unknown reason, it has remained unaltered through countless ages. Presently, in hunting about, we find the dark irregular opening of a cavern and, preparing torches, wriggle cautiously into the hole. Just within the opening, which is nearly closed by masses of fallen stone, the cave opens out and, standing erect, we gaze about upon a scene from fairyland.

Walls, roof, floor, all are dazzling white, glistening and gleaming as though covered with hoar-frost and flashing back the light from our flaring torch like myriads of diamonds. From the ceiling, a few feet above our heads, hang thousands of stalactites, ranging in size from tiny, needle-like affairs to huge, pendant cones, some a few inches in length, others reaching almost to the floor, while here and there huge fluted columns join the floor and roof and everywhere stalagmites rise upward like inverted cones from underfoot.

Masses of rock which have fallen from above are strewn about, but all so covered with a coating of the crystalline limestone that their

true character is lost and they appear as great, rounded mounds of scintillating jewels. In spots the dripstone seems to have formed great pools upon the floor and lies in irregular masses and looking for all the world as if a bucket full of molten stone had been poured out upon the bottom of the cave. In places, too, the stone has formed broad, thin sheets, like curtains between floor and ceiling and almost as transparent as window-glass, while in other spots it has moulded itself into domes of dazzling crystals, so symmetrical, so beautifully fluted and grooved and carved that it seems the work of human hands. From the stalactites water is constantly dripping, and if we examine the smaller ones by our light we actually can see them in process of formation. Within their transparent depths we see a central tube filled with liquid and at the tip a drop of water hangs. And as we look we see tiny needle-like crystals forming in the drop and attaching themselves to the stalactite, each drop of water adding a few more crystals and, bit by bit, enlarging and lengthening it. Slowly, very slowly, do these stalactites grow,

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and still more slowly do the stalagmites build upward from the lime-impregnated water which drips from the roof above. Drop at a time, the water seeps through many feet of rock from the surface of the hill above us, carrying with it the soluble lime and, drop at a time, it clings for a moment to each pendant needle and deposits a minute quantity of mineral, and we realize how many centuries must have been required to build up all this mass of stone, all these thousands of huge columns and domes and stalactites and stalagmites by this immeasurably slow method of dripping water.

Carefully picking our way among the columns and the stalagmites we walk forward down a slight descent, the wonderful drip-stone formations becoming more and more elaborate and beautiful as we proceed, until, suddenly and without warning, we step into cold water up to our knees! Drawing back in surprise we hold our torch low and peer ahead and find that as far as we can see the cave's floor is covered with water, but so clear and so transparent that it is as invisible as air, save for the reflection of our torch upon

its surface. In the water we see scores of fish swimming about; big snappers, flashing yellow-tails, striped angel-fish, and many others, and we realize that this subterranean pool is connected with the sea and that these finny denizens of the cavern find their way here by way of crevices and submerged passages through the rocks. Had we a boat or raft, we might paddle about for hours upon this grotto lake, for many of these caverns in Aeolian rock are of great extent and stretch for miles in a labyrinth of aisles and passages and chambers; but as no craft is available and the water blocks our further progress, we are compelled to retrace our steps and crawl back to the outer world through the narrow entrance.

But there is a marvelous fascination about caves and an irresistible lure in exploring unknown caverns, and we wander about the cliffs of Aeolian rock searching for another grotto. In one spot near the sea we find a splendid natural arch which at first we think has been worn and cut through the rock by the waves, but it is many yards from the high-water mark

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and when we examine it closely we find no signs of wave-cut rock, but instead a coating of weathered and discolored dripstone covering its inner surface and, here and there, the remnant of a broken stalactite hanging from the curve of the arch. Thus we know that once this arch formed the vaulted roof of a cave much like the one we have visited and that for some reason the roof broke down, the fallen masses of rock became broken up and washed away and finally only a single supporting column of hard dripstone and a single curved section of the roof remained to form this graceful arch of stone.

In another spot we find still another broken down cavern with all signs of the roof gone and only a group of fluted, tapered columns standing, while at the very edge of the sea we come upon a huge circular hole filled with water and alive with fish and marine animals, and upon the bottom of which we can still trace a few coral-incrusted stalagmites. Indeed, all along this rugged coast of the island we can find numerous traces of caverns which have long since tumbled in or have been

broken down by the sea, and we realize what an important part the caverns play in the formation of the island and how the waves, constantly hammering at the cliffs and inch by inch eating into them, at last reach a cave and, thundering into it, tear away the supporting columns until the roof falls crashing down, leaving great masses of the soft, freshly-broken rock to be broken and ground into tiny fragments and reduced to the sand from whence it came until at last another deep cove in the shore line results with only a few of the stouter pillars of dripstone standing like monuments in the midst of the water. And if the extent of Aeolian rock should be great, or if the island consisted wholly of it, we would find that, far back from the sea, other caverns had fallen in and had left great irregular-shaped basins in the rock. Some of these we would find filled with water and forming lovely pools, lakes or lagoons, while others would be filled with rich, red earth—the product of decomposed limestone and decaying vegetation—and in which plants grow luxuriantly. Such sink-holes, as they are

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called, abound in islands of Aeolian formation, and it is in them that the vegetables, lilies and fruits of the Bermudas are raised to such perfection.

But on the island on which we are standing the Aeolian rock is of small extent and forms but a section of the island's formation, for this isle is a combination of coral, volcanic and limestone and, half a mile off the coast, we see a dark line of reef against which the long swells are breaking, and towards this we make our way. As we row towards the reef we pass several isolated masses of rocky appearance upon which the gentle swells burst with a vast amount of foam and spray and, drawing near, we are at once struck by their form. Oval or round in shape and several yards in diameter, these consist of a circular rim or ridge enclosing a pool of water, and instantly we note that they are exactly like miniature coral-atolls. If we stepped upon one and examined it closely we would discover that it was formed of immense numbers of odd, twisted and worm-shaped shells and that it supported a vast amount of marine life. These

shells are the homes of a certain kind of marine worms known as *serpula*, and the atoll-like formations are known as "serpuline-atolls" or "boilers." Originally they were knobs of rock or coral projecting upwards from the bottom of the sea. Then the worms covered their surfaces with their living armor of shells, and as these creatures thrive best where the water is constantly churned and disturbed, they grew thickest around the outer edges of the mass. Then the sea, breaking against the obstruction, found itself baffled by the ever-growing *serpulæ* and gradually it wore away the unprotected centre until a circular ring of worm-shells resulted and the worms, ever increasing and adding to the outer edges, and dying or retreating from the protected interior pool, have built the little atolls larger and larger. Very interesting are these and, in a way, apt illustrations of the formation of the true atolls of the south seas, for the principles involved are identical and we have only to substitute corals for worms and increase the size of the boilers in order to have a true atoll.

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Beyond these interesting atolls we pass into the calm water behind the reef which acts as a breakwater, and presently the water grows more shallow, the same marvelous sea gardens are spread beneath us, and, a moment later, our boat grates against the inner edge of the reef. The tide is out and we step dry-shod upon a huge mass of spreading, living coral. But we must have a care, for the coral is slimy and slippery, and we find that, instead of the dry dead surface we are accustomed to associate with corals in museums, this coral on which we stand is covered with a somewhat gelatinous layer or coating. This is the skin, if we may so call it, of the coral animals which produce the lime skeleton of the mass. They are now contracted and withdrawn into the innumerable star-like openings or calicles of the coral, but if we search about a bit we will find a number of corals with expanded animals in a water-filled pool in the reef nearby.

Here is a wonderful and beautiful sight, a pool whose sides and bottom appear to be composed of a solid mass of multicolored, delicately formed flowers which wave

their petals gracefully in the water as it rises and falls slightly to the swell beyond the reef. Sea-anemones you think, but in this you are mistaken, for these delicate flower-like growths are the expanded animals or polyps of corals. Here is an irregular mass of pale sage-green with petals blotched with rich mauve and white—a rose coral, so called from the rose-shaped calicles of the skeleton; beside it a circular, closely-packed group of smaller fawn-brown with intense yellow petal-like tentacles indicates an orbicella or star-coral—a handsome species with its globular surface studded with star-like calicles; close against this is another rose-coral with its polyps intense emerald-green, and just beyond still another of Quaker-gray stripes and ringed with mauve. A large mushroom-coral appears like a layer of plum-colored velvet until we look closely and see its surface is composed of countless tiny polyps with tentacles of brown and violet, while close to it rests a young brain coral of vivid orange encircled by branching oculinas with their graceful twigs and stems adorned with dainty lily-like

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polyps of seal brown dotted with blue.

Deeper in the pool madepores and stag-horn corals range in color from scarlet to black, with every imaginable shade and tint filling every space and opening between them, while for good measure are great patches of brown and green and red zoanthus, stiff flower-like animals which are somewhat intermediate between sea-anemones and corals. And now, as we watch the fascinating coral animals more closely, we see minute, white, thread-like filaments projecting from them and we note that the tentacles are constantly drawing suddenly in and contracting about the little opening in the centre of each separate animal. The tiny threads are stinging organs with which the polyps kill or paralyze minute creatures on which they feed, and each time the tentacles draw in they carry some morsel of food to the mouth in the centre of their disc, for corals are greedy, carnivorous creatures and woe betide any microscopic creatures that pass within their reach.

Then, when we have watched the corals long enough, we reach within the water and

touch one of the soft polyps and instantly every flower-like growth upon that coral disappears and only a slimy, fleshy, colored mass remains, for each animal can withdraw itself within the calicle or opening in the coral beneath it and thus protect its delicate tentacles from injury. Moreover, every individual polyp feels a touch or a sensation of any sort upon any portion of the surface of the coral, for while their internal organs are separate and each fills its own particular calicle, yet their outer surfaces or skins are all connected and cover the entire surface of the lime skeleton with a sensitive nervous system.

And constantly, as they eat and grow, each separate polyp is adding lime to the calicle beneath it, while, over the whole surface, the pulpy mass of the entire colony is building up the coral in the distinct pattern and system designed for it by Nature. Ever as it grows and increases in size, tiny new buds are forming in the mass and are developing into new calicles bearing new polyps while the almost microscopic progeny of the colony

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are floating far and wide and attaching themselves here and there and starting new masses of polyps and coral, just as a plant may increase in size by constantly budding out and producing new leaves and flowers, while, at the same time, its seeds are scattered by the winds and, taking root, form new plants. Thus we see that the corals, although living, carnivorous animals with power of individual action, growth, digestion, reproduction and other functions, yet resemble plants in some ways, and while the surface covering and the polyps within the calicles are very much alive yet the stony mass beneath them is dead, devoid of sensation and forms merely a support or foundation for the animals themselves.

Perhaps you wonder why corals ever die or how they are detached from the rocks and other corals to which they are so firmly cemented; but if we pry one loose we will find that they are not very firmly attached and that the under⁴ surface is rotten in spots and is honeycombed with holes and is filled with a great variety of marine life. Boring-sponges are numerous; there are countless shells, many

worms, quantities of crustaceans, starfishes, sea-urchins, sea-anemones, hydroids, molluscs, and probably a few small fishes, all lurking in the holes and cavities. Indeed, there are few spots where there is a richer collection of marine animals than in the bases of corals, and naturalists obtain many of their rarest and choicest specimens by breaking up corals.

Very many of these creatures drill or bore their own holes and retreats in the coral, and eventually it becomes so riddled that a very little force is required to break it free from its surroundings. And as the same wave or storm or blow that breaks it loose moves it about or turns it over, the polyps soon die and the dead coral lies at the mercy of the waves which knock it and beat it about—using it as a battering ram with which to destroy more corals—grinding them together, breaking them, and at last reducing them to fragments which are cast upon the beach or reef. As we wander about upon this coral-reef we will find many such dead corals, some with a portion of the polyps still living and striving to repair the damage and to increase, others only recently



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torn from their fastenings and with the decaying animal matter still covering them, still others cast high upon the reef by the breakers and bleached to snowy whiteness by the sun and water, and many more smashed and broken where they have been dashed together by unusually heavy seas. In between the corals and in the bottom of the pools of water on the reef we will find layers of fine white sand which, when examined, is found to consist entirely of pulverized coral, and in some spots we will find the hollows completely filled with this.

We will also very soon discover that the water on the seaward side of the reef is deep and the reef is steep and precipitous, whereas, on the landward side where the water is calm, we will find that the water is shallow and the bottom of white sand slopes gradually from near the top of the reef. Also, we will note that the majority of the dead corals as well as the pools and crevices filled with their fragments are near the inner edge of the reef, and we can easily imagine how in the course of years the sloping floor of sand beneath the sea

would be piled up until a beach extended along the inner edge of the reef, and how, by degrees, all the wide area of still water between it and the distant island would become shallower and shallower until at last a bare expanse of sand would connect the reef and the shore at low tide; how drifting seeds and nuts and flotsam of many kinds would be left stranded as the tide receded; how some of these, such as the mangroves and black-jack and sea-grasses, would sprout and grow, and how, little by little, the area of water would be transformed to a wide sand-flat which, dried by the sun and whipped into dunes by the wind, would eventually—in inconceivably distant times to come—become Aeolian rock when the shore of the island would be the outer surface of the reef on which we stand.

Now, having learned by personal observation and study how coral reefs and coral sand and Aeolian limestone are formed, we will travel to another part of our tropic island and see Nature's most terrific forces at work, for we will visit an active volcanic crater.

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Several miles from the reef a deep semicircular bay cuts into the island with a long, curving, rocky point on the further side and with precipitous cliffs rising sheer for a thousand feet above the sea on the other hand. As we pass beneath these beetling precipices we see that they are very different from the Aeolian rock, the elevated coral reefs or the solidified tufa and laval-bombs which we have seen and that they are composed of hard, fine-grained rock curiously pitted and cracked and worn by the elements. If we should row across the bay to the rocky point and headland we would find the same material there, and if we should fly over the bay in an aeroplane and look down we would discover that the cliffs and the point formed, with the shores of the island, a perfect circle with only a narrow opening or gap of water breaking the curve, for this lovely bay is the crater of an ancient volcano which belched forth steam and molten rock in ages past, while the cliffs under which we are passing and the point beyond are portions of the crater's outer rim broken through by the sea, to form the almost-landlocked bay.

Beneath us the water is immeasurably deep, its dark indigo tint indicating tremendous depths, and a sounding line dropped overboard would find no bottom at one thousand fathoms, for this ancient crater was immense and the space now filled by the sea goes down, like the bottomless pit, to the very bowels of the earth. Involuntarily you shudder as you think what might happen should this old volcano suddenly awake. Of course it is dead, you say, and there can be no danger, but wait a few moments and you will find that life still lurks beneath these countless fathoms of water.

Now we have entered the bay and gaze enraptured at the beautiful scene before us. In a marvelously perfect semicircle a sloping beach sweeps from the jutting point to the cliffs; but no beach of snowy sand is this; instead, it is black as ebony and along its edge the indigo sea breaks in a line of dazzling white. Above it stands the inevitable cocoa-palms and beyond stretches an enormous bowl-shaped valley bounded by towering forested mountains. Then, as we gradually absorb the details of the scene, we notice that the big

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mountain in the background has a vast, purple-shaded, circular hollow in its flank; that spots of dull red and yellow and glaring white break the greenery there and that from it a cloud of steam is floating upwards, while, if we listen, we will hear a distant rumbling sound and ever and anon a strong odor of sulphur is borne to us on the breeze.

The bowl-like hollow upon the mountain is the active crater; the beautiful mountain-bound valley is a much larger and more ancient crater, now inactive, and the bay upon whose surface our boat rests is a still larger and more ancient crater still. Doubtless, when the island was young this vast water-filled crater rose thousands of feet above its present level and dominated all, then, as its activities died down, a newer and smaller volcano burst through the earth and tore the crater which, when it too died down, formed the lovely verdured valley. Subsequently a still smaller eruption took place still further from the sea and produced the active crater which lies smoking and steaming and rumbling upon the mountain's flank like some ugly

threatening monster growling in its lair and ever threatening to leap forth and rend and tear and desolate the fair surface of the land about.

Now we are close to the beach, but ere we land, turn your attention to one side and note that strange disturbance in the sea, as though a great school of fish was agitating the surface of the water. Approaching closely, we see that it is caused by great bubbles rising from beneath, and if you place your hand in the water at the spot you will find it scalding hot, for deep down under thousands of feet of sea life still exists in the old crater, and if further proof is needed examine that ledge of rock projecting from the beach and you will find steam rising from it, or dig a hole in the beach sand and bury eggs within it and in three minutes they will be boiled to perfection.

Even on the beach of black, pulverized lava are signs of volcanic action. Bits of water-worn sulphur, fragments of flinty volcanic glass or obsidian and masses of pumice-stone are strewn among the shells and weed and other flotsam cast up by the waves, and a little



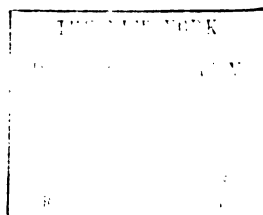
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stream which flows down from the valley and cuts a channel across the beach is scalding hot and smells abominably of sulphuretted hydrogen. Beyond the barrier of thorn and scrub and sea-grape trees along the beach we find fairly open country covered with coarse grass and weeds and clumps of guava-bushes, with here and there larger trees, and with little trouble we trudge across the valley's floor and ascend the mountain-side towards the active crater. As we proceed, the rumbling becomes louder, the sulphurous fumes become more pronounced and the character of the vegetation undergoes a change. There are many large trees, a true forest in fact, but in place of the dense undergrowth we see coarse bracken-like ferns, strange giant club-moss, spindly bromeliads with scarlet flowers, and a few cacti, all forms of plants which are adapted to thin, poor soil and intense heat and dryness.

Then the big trees all disappear, we find ourselves in a waste of bracken and strange "horse-tails" and club-mosses, the hissing roar of the crater drowns all other sounds,



STALACTITES IN A CAVE ON A LIMESTONE ISLAND.



the rocks scattered about are glaring red, yellow or black, tiny streams of steaming water trickle through little gulleys coated with a white and yellow incrustation, and with difficulty we cross a good-sized brook of boiling water. Following the stream up and clambering over masses of burned rock and through blue-black mud, we reach a cleft in the crater's rim and look upon a scene which might well be the original of Dante's *Inferno*.

Before us lies the floor of the crater, a vast circular plain of red, yellow, black and white, crisscrossed by streams of inky-black or milk-white water from which vapor rises in clouds, and with a hundred jets of roaring steam spouting from cracks and openings in the earth with a deafening roar. And, ever and anon, these jets of scalding, hissing steam change places, dying down in one spot to break forth with renewed vigor a few yards distant; hurling great masses of rock and tufa into the air and playing upwards like the stream from huge fire-hose, for a hundred feet and more.

On all sides the crater's walls rise bare, seamed and burnt in dull reds and yellows,

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with here and there great patches of brilliant yellow sulphur glittering in the sunlight, while, around the crater's rim stand the gaunt blackened skeletons of forest trees which have succumbed to the gases and the heat of the crater or were killed and charred in the last of its outbursts. Underfoot the ground trembles and shakes as though but a thin crust separated us from the boiling, agitated, incandescent centre of the earth, and the rocks and mud upon which we tread are so hot that the soles of our heavy boots are burned and cracked. And it is a far from comfortable or stable spot, for if we remain standing in one place for a few moments we find boiling mud oozing up about our feet, while, if we push a stick into the earth, a jet of scalding steam will spout several yards into the air. There is grave danger, too, for one never knows when or where a geyser of steam may break forth, or in what direction it may spout, and we breathe a sigh of relief when we have picked our way across this perilous area and find ourselves upon a sloping pile of dry and cold cinders and ash. Ahead of us, and towering

upward for near a thousand feet, stands a beautifully-tapered, pointed pinnacle of ashes, the needle-like cone formed by the last eruption which tore off millions of tons of the mountain side and scattered the broken rock and sand and dust far and wide upon the island, while from the crater flowed a sea of scalding mud and fiery, white-hot lava-bombs fell like a barrage of titanic artillery upon the surrounding hills and valley. But all is quiet now, the giant sleeps for a time and the waste of mud which a few years ago covered the country and choked the river under a hundred feet of the hot black mass has been cut and washed by rains and overgrown with tropic verdure until no sign of it remains. Slowly but surely the torrential rains of the tropics will beat down the cone of ash and water will fill the crater and transform it to a placid lake beneath whose surface will rest the forces which have torn the mountain asunder, have raised an island far above the sea, and which at any moment may awake and, in a sudden outburst, blow the island into atoms.

CHAPTER XI

THE ISLAND OF SALT

A LOW, long line of yellow sand, strewn with the weather-beaten skeletons of wrecks and capped by a ridge of dusky green. At one end a solitary lighthouse, at the other a little cluster of buildings under nodding palms and a fleet of sloops and schooners off the shore: such is the appearance of Turks Island as viewed from the sea. A flimsy, wooden dock projects from the sandy shore into the sea and, ferried in a scarlet and blue rowboat pulled by a half-naked Herculean negro from the steamer to the dock, the traveller steps ashore to find himself the centre of a world of color. Colors, black, brown and yellow of faces, arms, bare feet and legs; colors of every rainbow tint in ragged clothes; colors vivid beyond belief in the flashing fish piled in trays and baskets offered for sale; colors of pearl and rose and glorious sunsets on the sea-shells

and curios borne by the gabbling crowd insistently urging you to buy, and color of sapphire in the sky and of turquoise in the limpid water breaking in creamy white foam along the golden-yellow beach.

And then your eyes are dazzled by a huge pile of snowy white beside the road leading from the dock, and as you pass along you are surrounded on every hand by similar piles, like enormous snowdrifts, towering far above your head and half concealing the unpainted wooden houses and shops along the way, and all of salt—veritable mountains of salt glaringly scintillating in the sun. At first you think the island must be made of salt, for the narrow street is lined with it, you crush it under foot, drays and carts are laden with it, sacks of it are being stacked like fortifications beside sheds, men are shoveling it into or out of trucks, and the dust whipped from the road by a gust of wind tastes of salt. And everyone talks salt; it's the one topic of conversation, the sole interest of the inhabitants, for this is the island of salt where nothing else is taken into consideration. Here salt is king and

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queen and rules all. The British flag flaunts itself in a splotch of scarlet above the government buildings, but it is salt that maintains it there and makes the buildings worth while. Mail and cable news hold little of interest if there is no word of the world's markets for salt. The arrival of a ship or steamer is an event, but the freight of passengers they bring are forgotten in the question as to whether they can load salt. You will hear the people talking of good or bad crops, good or poor harvests; so many acres raised or so many harvested; but they are speaking not of vegetables nor grain nor grass, but of salt, for salt is the sole and only product of the island, and upon the size of the salt crop depends the poverty or affluence of the people and the prosperity, aye, the very existence of the island.

It is the only interesting thing, for all else has been denied the little isle by Nature. The spot is barren, dry and featureless, a waste of sand and gray rock, its only vegetation mangroves and dismal gray-green weeds and coarse grass, aloes and cactus, and though a

few trees and vines and some shrubbery and flowers adorn the grounds about the better houses in the town, all have been brought from overseas and the very soil they thrive in was imported from Santo Domingo and is carefully cherished and confined to the tubs or boxes or plots wherein the few cultivated things grow. And so, as salt is everywhere and there is naught else to see, let us busy ourselves by viewing the salt farms and watching the strange crop planted, raised and harvested.

Following along the well-worn sandy road over which mule carts laden with salt are constantly passing, we leave the town behind and come to a vast broad space divided into rectangles by dykes of mud and with strange windmills rising above them. Very striking are these affairs, consisting of huge crosspieces bearing fore-and-aft or leg-o'-mutton sails attached to upright masts on the extremities of each cross-bar and looking, as they revolve in the wind, for all the world like four or six sloops chasing one another forever on a circular course. Between the dykes the mud is



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level as a floor and packed hard, and in many of these we see men busily at work with rakes and hoes and shovels, while in others there are rows of mule carts with negroes shoveling crude salt into them. These are the salt farms or, as they are called, the "salt-pans," and in them all the vast quantities of salt are raised and harvested. And now we see that the toiling workmen are hoeing, raking and shoveling the salt from the bottom of a "pan" wherein the crop is ripe and ready to gather, while others are filled with water, others are partly full of a dirty, sirupy-looking mess and still others are covered with a thick coating of dull-colored salt crystals. Here, then, is the salt crop in all stages of its preparation, and we can start at the beginning and see exactly how it is prepared or raised.

We find that between the sea and the first pans there are gates or sluices in the dykes, and by opening these the pans are filled with sea water and the sluices are again closed. Under the blazing tropic sun the water rapidly evaporates until a thick concentrated salty brine remains, and this is pumped, by means

of the boat-like windmills, into the second series of pans and the first pans are filled with a fresh lot of sea water. As the water in the second series evaporates still more, the sirupy mass is pumped into a third set of pans, where it soon dries into dirty salt crystals which are raked up and carted away to be piled into miniature mountains, while the second crop has taken its place in the pans. In this way there is a constant succession or rotation of crops being harvested through the dry season, for the salt cannot be dried and produced during the rainy months.

Even when the crop is harvested and piled it is not ready for shipment, for it is a dirty, discolored mass, bitter with the various salts of sea water and must be left to "ripen" until the impurities have been carried away by exposure to the weather. Vast quantities of the coarse brownish salt are shipped for use in various industries, but immense quantities are also ground and further purified on the island, to be shipped in sacks and barrels to all parts of the world, and vessels of every nation and of every size drop anchor in the little harbor

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of this Bahama isle to load with the famous Turks' Island salt. One marvels what becomes of such stupendous quantities of salt, for Turks' Island alone produces millions of bushels annually and the nearby islands of Little Turk and Caicos add as much more to the supply. Verily are the Turks Islanders "salt of the earth." But despite the fact that their lives, their energies, their industry and their minds are devoted to salt and that their tiny island home is quite out of the world and almost unknown to most people, yet they are by no means backward or ignorant or out of touch with their fellowmen. Cables keep them well informed of what goes on in the great world outside their tiny islet, a mail and passenger steamer calls regularly at the port and brings the supplies upon which they depend for existence; they have schools and entertainments and they are intensely patriotic and as passionately fond of their island as though it were a vast, rich kingdom, instead of a mere strip of barren, ocean-girt sand with its only resource, its only product and its only reason for existence, salt.

CHAPTER XII

THE ISLAND OF PEARLS

FROM the very earliest times man has placed a high value on pearls and has sought for them wherever they occur. And as pearls occur in nearly all parts of the world, pearl fisheries have been, and are still, carried on in nearly all countries. There are fresh-water pearls found in the mussels of our rivers, pearls in the common edible oyster, pearls in clams, pink and yellow and brown pearls in conch shells, and, most valuable and highly prized of all, the pearls of the pearl-oysters of tropical seas. There are many species of these and they are found in many seas, but only a few localities have produced enough or sufficiently valuable pearls to become famous for them.

Many very fine pearls come from Ceylon, others from India, others from Africa, others from Australia, others from Papua, and the

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South Seas. Countless pearls have been obtained from the Pacific Islands, and Japan has not only furnished many natural pearls, but with true Japanese ingenuity and love of imitation, the Japs have learned to make the pearl-oysters work for them by producing pearls to order. Even the little island of Margarita, off the coast of Venezuela, has furnished millions of dollars' worth of pearls in the past and the pearls and pearl-shell fished there today amount to a value of nearly one million dollars a year. But of all places, none have been so famed for pearls and none have so well earned the right to the name as the Pearl Islands in the Bay of Panama.

When Balboa first crossed the Isthmus of Panama he was told by the Indians that the faint, hazy land he saw upon the horizon was a group of islands where there were many pearls, and later, when the Spaniards had built ships to make the voyage, they found the natives of these islands using pearls as decorations on their dug-out canoes. It must have been a marvelous surprise to the treasure lustful Dons to see pearls used in this wasteful

manner, and we may be sure they soon extracted all the pearls in the canoes and robbed the simple natives of their store. But to the Indians pearls were merely pretty, glistening objects with no particular value, for, after all, the value of anything depends upon the demand for it, and the only reason that pearls are valuable is because they are not common and the demand is greater than the supply. If someone should find a bed of pearl-shell where pearls were found in every oyster, the world's markets would soon be glutted with pearls and they would be worth little, if any more, than the shell itself which, known as mother-of-pearl, is utilized for buttons and other cheap things, although it is just as beautiful as the pearls themselves.

But as long as pearls are valuable and scarce they are interesting and surrounded by romance and a certain fascination. So let us take a trip to the famed Pearl Islands and spend a day or two with the pearl fishermen.

Four or five hours' trip by launch will take one from the modern, busy, up-to-date city of Panama, or the American town of Balboa at

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the Pacific end of the Canal, to the Pearl Islands. The islands are very beautiful, covered with luxuriant tropic vegetation and waving palms, with lovely beaches and towering mountains, and surrounded by a marvelous sea of azure and turquoise. Scattered along the shore beneath the cocoa-palms are numerous thatched and wattled huts with fishing boats of gay colors drawn upon the sand before them, and here and there are little villages.

There is only one town worthy of the name upon the islands, San Miguel, a good-sized, picturesque spot, but ill-smelling and dirty, for the people are mainly negroes or colored folk and very lazy. Aside from pearling, which is only carried on during certain months of the year—for the Panama government has wisely set a close season on the pearl-oyster beds in order to protect them from being exhausted—the only real industry of San Miguel and the Pearl Islands is fishing. To be sure, they raise many cocoanuts; they have little farms and sell pineapples, fruits and a few other products; they weave coarse palm-leaf hats and they carry on a meagre trade with

the mainland; but all these are purely side lines and the people eke out a miserable but perfectly happy existence by fishing. Fish swarm in the waters about the Pearl Islands and tons of fish are shipped by special launches every day to the Commissary Department of the Canal Zone. But with the opening of the pearl season every man who owns or can borrow, beg or steal a boat turns his attention to the pearl-oyster beds about the island. If a man finds a good-sized pearl he can retire from work for life, but he usually spends all he receives for it in vile liquor and goes on a prolonged spree. But even if he finds no pearls, and there are few who do not find some, he can make more money on the pearl-shell than he can in any other way. The native uses no equipment for his pearling work, but paddling along until he finds a good bed of shell, dives overboard naked, with a basket or sack slung over his shoulders, and with a short iron bar or an old machete in his hand.

Looking over the boat's side we see him as he swims down, the pink soles of his feet towards us, and presently we see him poised

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above the bed of shell, a rough, irregular black line at the edge of a rocky ledge and with wonderful sea-fans, strange sea-rods, brilliantly-colored corals and giant sponges growing all about. But now the diver is busily prying and knocking the oysters from their ledge; the water becomes murky with the bits of dirt and mud loosened by his efforts and the bottom is lost to view; a moment later the fellow's head bobs up close beside us and, blowing the water from his nostrils and rubbing his eyes, he reaches the boat's side, throws his sack of shell within and clambers aboard. Presently the water is again clear, the bronze-skinned pearler has regained his breath, again he swims downward to the oyster bed, and again he dumps a sack full of rough blackish shells into the boat. We wonder that any human being can remain under water so long, for he seems to us to be working away at the oyster bed for ten minutes at a stretch, but if we time him we will find, to our surprise, that he is never under water over two or two and a half minutes.

At last he has secured a sufficient amount

of shell, or has become tired, and, seating himself in the boat, he proceeds to open the shells he has secured, unless, as is often the case, he has a comrade who opens the shells as the other dives and then changes places. Under the laws of Panama all refuse and meat from the shells must be thrown into the sea far from land, and so the Pearl Island fishermen are compelled to open their catch in their boats instead of carrying them ashore and allowing them to rot, as is done in many places. As each of the big round shells is opened the diver scrutinizes it carefully, and then, if no pearls are within, tosses it into a heap to one side. Suddenly his face lights up, his lips part, and a satisfied grin spreads over his countenance, and he holds up a shining, iridescent sphere for us to see. "A pearl!" you exclaim. Yes, a pearl, and a very perfect one in color and shape, but small. But the diver is well content, he knows his afternoon's work will net him at least fifty dollars, and with keener interest than before he works feverishly at his pile of shell.

The sight of the first pearl has excited us,

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too, and we crowd close, watching breathlessly as oyster after oyster is opened, and the native, noticing this, indicates a pile of shell and tells us to help ourselves. Eagerly we seize the oysters and commence our search. A moment later we feel a thrill as we catch sight of a rounded, shimmering mass partly exposed in the soft meat, and, filled with excitement, reach for it, but it is merely a "baroque," a protuberance like an irregular pearl attached immovably to the shell, and, disappointed, we cast the shell to one side, only to see it seized by our native friend who places the baroque shell by itself, for baroques have a market value far greater than the ordinary mother-of-pearl. Shell after shell is opened, the native has secured half a dozen fair pearls and a number of tiny seed pearls when, opening a rough, warty, misshapen shell which we have been about to cast aside, we utter a cry of success, for, nestling within, are two lovely pear-shaped pearls of perfectly matched color and size. Enviously the diver looks upon our find, and muttering the Spanish equivalent of "fool's luck" continues at his work. But no

more pearls reward his or our efforts, and, as the sun is sinking behind the mountains, we help our friend clean out his boat, we heave the mess of meat and mud and litter from the shells into the sea and row slowly towards the diver's little hut upon the beach.

The next day we board a larger craft, the boat of a company with headquarters in Panama, and who use more modern and efficient methods than the native diver. Here we see a complete diver's outfit with helmet, air-pump and all complete, and when we reach the selected beds the divers don their costumes, the air-pump clanks, and, armed with tools and sacks, the men slip over the side and half drop, half sprawl downwards to the bottom. Here the sea is much deeper and we can see nothing of what is going on beneath us, but constantly bubbles rise to the surface, sack after sack of shells are hauled up on deck, and a huge pile of oysters accumulates which are rapidly and deftly opened by the men.

But this is apparently a "lean" bed and no pearls of any size are found, though bushels and bushels of shell are opened. However,

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there are many interesting and strange things to be found among the mass of oysters sent up by the divers from the bottom of the sea. Sea-shells of many kinds and great beauty, mitre-shells checkered in white and orange; cone-shells of marvelous tints; olivas and cowrys, harp-shells and rose-hued, spiny oysters, with here and there an odd sea-urchin, a many-rayed, purple or scarlet or emerald-green starfish, and an occasional bit of branched, cerise-pink coral, a sea-fan or some strangely shaped and gorgeously colored sponges.

Even in the pearl shells themselves we find curious and interesting things. Here, in one shell, is the perfect outline of a fish, complete in every detail but formed entirely of dark-colored, lustrous nacre, while in another is a pearl-embedded crab, for any object which finds its way within the oyster and lodges between the meat and the shell is soon covered with a coating of the pearly nacre and is thus preserved, perfect in form, for all time. It is this habit of the pearl-oyster that produces pearls, for pearls are merely bits of foreign matter covered with nacre and which, for one

reason or another, are free from the shell itself. Indeed, many pearls are found which are slightly attached to the shell, while others form a part of it and are then known as "baroques," and there is every gradation from the rough, irregular baroques to the most perfect, free, spherical pearls. Almost any object, a bit of sand or pebble, some tiny animal or, in fact, anything which becomes lodged in the oyster and causes irritation will soon become covered with pearl, and the wily Japanese take advantage of this fact and by inserting little spheres in the oysters produce pearls at will. Oftentimes, too, they place tiny images of Buddha in the oysters and, after these have become coated with pearl, sell the shells to tourists as curios. Just why some oyster beds produce large numbers of pearls while in others pearls are rare is not definitely known, but according to some scientists who have made a deep study of the pearl-oyster, free pearls are only formed when the spherical eggs of a certain parasitic worm lodge in an oyster. This worm, in its adult state, lives in certain species of sharks, and it is alleged that

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it is only in waters infested by these sharks that true pearls are found. If this is so, then, after all, sharks are of benefit to man, while the beautiful pearls which we admire so much owe their existence to the eggs of a loathsome parasitic worm!

CHAPTER XIII

WHERE PEOPLE DWELL IN A VOLCANO

IF you will take down your geographies and turn to the map of the West Indies you will find two tiny pin-point-like dots lying between the British island of St. Kitts and the American island of St. Croix. Unless the map is a very large one, however, you will find no names given to these specks; but they both belong to the Dutch, the one nearest St. Kitts being St. Eustatius or "Statia," as it is more commonly called, while the other is the island of Saba. In olden days Statia was a very rich and important island, though now almost dead and forgotten; but it should ever be remembered and held dear in the hearts of patriotic Americans, for it was here that the American flag was first saluted by the guns of a foreign power and the bluff old Dutch governor who thus honored the Stars and Stripes brought a

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veritable hornet's nest around him, as by his act for Britain ruled the seas as about his island and loudly, from the mouth of her cannon, resented this recognition of her revivifying colony's flag. But it is the other island, Saba, with which we are concerned, and truly there are few islands in all the world more strange, or a town more remarkable than this little Dutch colony in the blue Caribbean Sea.

Barely five miles in diameter, Saba rises from the sea in sheer, beetling cliffs a thousand feet in height and tapering gradually in an enormous cone to a cloud-draped summit nearly six thousand feet above the sea. Above the red and gray rocky cliffs, against which the sea hurls in white foam incessantly, a mantle of green spreads over the slopes to the very summit of the mountain, but one may sail around and around the island and see no signs of a town or village; a few tiny white houses nestling amid the verdure on the mountain-top being the only signs that Saba is inhabited.

One might sail many times about Saba ere a landing place was found were it not for a low building with the Dutch flag flying

above it which squats near a flattish ledge of rock and a sloping patch of coarse shingle at the bottom of a deep gulley stretching up the mountain side. If we wish to visit Saba or "go aboard" as the Sabans call it, we must choose a calm day and land in a small boat on this one and only beach, and even in the smoothest weather it is by no means easy. The ocean swells break in heavy surf and the stalwart black crew leap into the sea and fairly drag the boat through the breakers and the undertow and up the rough cobbles of the shingle. Above us tower the steep, rocky cliffs, but upward through the gulley runs a narrow way—a sort of path consisting of short, sloping stretches and irregular stone steps—800 of them—leading upward from the landing place to the mountain top a thousand feet above our heads. This hard and steep stairway is known as "the ladder," and, aside from a far worse and far steeper trail on the other side of the island, it is the only way by which anyone may scale the Saban cliffs.

But while it causes us to pant and sweat

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and to stop frequently to regain our breaths, yet to the Sabans it is nothing and they run up and down the ladder like goats, while every bit of merchandise, every barrel of flour and every other item brought to the strange island must be carried up the steep, stone stairway on the heads of men. But if the visitor finds the ladder too irksome, or if there are ladies in the party, the hospitable and accommodating natives will improvise a sedan-chair by lashing a rocking chair to two oars, and thus borne on the shoulders of two muscular negroes, one may be carried up the ladder in ease, or perchance, a shaggy, diminutive donkey may be provided and, if one's nerves are strong enough, one may cling to the little beast until, by scrambling and jumping and slipping, with imminent danger of tumbling with rider and all over the precipice, the creature scales the stairs and gains the mountain top.

And when, at last, either by foot or chair or donkey back, we reach the summit, we look upon a sight which well rewards us for all our efforts. Before us is an immense bowl-shaped

valley surrounded on every side by towering green mountains and divided up into neat squares and rectangles by stone walls, while near its centre nestles a veritable toy town. White-walled and red-roofed, the houses cluster about the little church, with outlying cottages scattered here and there and everything so neat, so orderly, and so thoroughly Dutch that it might have been transported bodily from Holland. And strange as it is to thus find a Dutch village tucked away from all the world on an island mountain-top, the place selected by the people is stranger yet, for the valley in which the town is built is nothing but a great crater, and quite in keeping with the topsy-turvy ways of the Sabans they have named their village "Bottom" although it is verily at the top. As we walk along the narrow lane leading towards the village we pass between walls of stone higher than our heads and behind which are neat orderly fields of potatoes, cabbages, peas and other northern vegetables, with here and there a fruit orchard or a patch of strawberries growing side by side with pineapples, bananas

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and other tropical fruits. In tiny gardens, filled with the old familiar flowers such as marigolds and asters, hollyhocks and stock, fuchsias and mignonette, stand tiny rock-built cottages with projecting eaves, steep roofs and shady "stoops" with gorgeous tropic vines and climbing roses rioting over them, while an apple-faced Dutch Frau peers out at the passing strangers and a gray-bearded old Mynheer sits smoking a huge porcelain pipe and greets us with a perfectly English "Good morning!", for the Dutch people who dwell here in the crater speak English instead of their native tongue.

But as we wander about the spotless little town we see few young men. There are women in abundance, countless tow-headed, blue-eyed children romp about, and gray-bearded, gray-headed, but still stalwart men there are aplenty; but the younger men are conspicuously lacking, for the Saban men are nearly all seamen—as they have been since the island was first settled—and sail the seven seas; some in their own swift, staunch schooners; others in square-riggers, and still others

as officers upon the great transatlantic liners; but invariably they return to their own loved, paradoxical island home to spend their declining years, though they see every land upon the earth.

Very strange it seems that the menfolk of such an out-of-the-world spot as Saba and such a town as Bottom, on an isolated volcano, should choose the sea for a livelihood, but the Sabans always regard their island as more or less like a ship and invariably speak of "going aboard" it instead of landing on it, and as their tiny vegetable fields and fruit orchards are limited in extent and the island has few resources, men must go abroad to earn their livelihood. Many are the strange customs of this stranger island, and we gaze in amazement as we see a gray-haired elderly couple carefully dusting and wiping off two coffins in their yard. But to the Sabans this is nothing new or strange, for it is a custom of the islanders to keep their coffins in readiness for the day when they will be needed and, at regular intervals, they are taken out and cleaned and kept spick and span like any other article of



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household furniture. Perchance you wonder how the Sabans make a living, aside from the earnings of their sailor relatives. Much of their income is derived from the fruits and vegetables they raise and sell in St. Kitts; much more is obtained from the sale of the beautiful drawn-work and laces which the women and girls make, while still more comes from the sale of boats. Perhaps you think this a joke, for it does seem ridiculous to think of boats built in a spot like this with no water nearer than the sea a thousand feet beneath and with not a single timber tree growing upon the mountains; but we may expect almost anything in Saba, and boat-building is the principal industry. Think of it! Boats built in a crater a thousand feet and more above the sea, and where every stick and plank and timber used in their construction must be brought up the terrible ladder on men's heads! And yet the Saban boats are found throughout the West Indies and are renowned for their speed and staunchness and seaworthiness. How, you may well ask, do the Sabans get their boats to the sea; surely they cannot carry them

down the stairway. No, indeed! The Sabans have a better way than that, and when the boat is done it is calmly lowered over the edge of the cliff with block and tackle, exactly as though the island were a ship and they were lowering a lifeboat! Truly it is "hard to beat the Dutch!"

Aside from Bottom there are several other small villages scattered over the crater floor, and the people never give a thought to the fact that at any moment they may all be blown to atoms, for although the floor seems solid enough and no eruption has occurred in historic times, yet the old volcano is by no means dead.

In several places hot water and steam are issuing from the rocks; there are hot, evil-smelling deposits of sulphur, and one ledge known as the "devil's warming pan" is always hot and dry even during the heaviest rains. Perchance even while this page is being written, the crater has burst forth in all its pent-up fury and the little town and its inhabitants have been blown to dust, or, again, the Sabans and their descendants may continue to dwell



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for centuries within the slumbering crater, building their boats, weaving their laces and raising their crops while awaiting the homecoming of their sailor boys. Let us hope that this will be the case and that for many generations to come no catastrophe may disturb or interrupt the lives of these peaceful, home-loving people who dwell in a volcano.

CHAPTER XIV

ISLANDS OF THE FROZEN SEAS

THERE are still other islands which are very different from those of our northern lakes and oceans or those of tropic seas and rivers. These are the islands of the far north and south—of the Arctic and Antarctic oceans—of the bleak, forbidding wastes of the polar regions. Some of these are very large, such as Greenland, while others are mere isolated rocks, for islands of the frozen seas vary as much in size as those of any other portion of the world. But here, in the storm-lashed, ice-filled seas, in the regions of perpetual snows, all is raw and crude and elemental and the polar islands are almost all harsh, forbidding and carved in bold, almost savage, forms by the most titanic forces of Nature from solid rock, for loose sand and earth and vegetation are scoured and torn away, save in the most sheltered spots and only enduring rock is able

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to withstand the awful forces of crushing ice, the terrific cold, the raging storms and the irresistible glaciers of the polar regions.

Here no forest or heavy verdure protects the rocks from the elements, and, naked and exposed, they stand forth in sharp-edged, angular relief against the vast expanse of gleaming white ice and snow. To be sure, during the short summer months low plants and shrubs and grasses spread a mantle of green in sunny spots where the frozen tundra thaws slightly and the melting snows form tiny rivulets or ponds, and here too, wild flowers bloom and a few hardy butterflies and insects flit about. And with the summer come countless birds to nest and rear their young upon these bleak bits of land. There are sea birds of innumerable species, great flocks of ducks and geese, waders big and little, and many a hardy species of finch and bunting and thrush and warbler.

One might perhaps think that in these out-of-the-world bits of ocean-girt, ice-bound land these birds could rear their families safe from molestation; but even here danger lurks

everywhere, and the constant ever-present struggle to exist is as vital and as cruel as elsewhere. Following the flocks, like a nemesis, come the fierce pirates and buccaneers of the air—the gyrfalcons, peregrines, skuas, jaegers and the great white owls, while equally fierce and even more destructive, are the four-footed murderers which lurk upon the desolate bits of land. There are the mighty polar bears, the white foxes, the ermines and the wolverines, while upon the rock-bound shores herds of walrus and fur and hair seals bark and frolic and rear their young, for life teems even in the polar regions. And just as Nature has developed forms of bird and animal life peculiar to islands and lands in the tropic and temperate zones, so in the frozen polar seas we find strange forms of life adapted to their environment. In the north there are the auks, the puffins and the guillemots, the sea-otters, the amphibious polar bears and the musk oxen, while in the Antarctic are still stranger birds and mammals. Here we find the albatross, the weird penguins and the mighty sea-elephants, with many a lesser

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creature with fur or feathers which is never found beyond the limits of its storm-lashed island home in the grim, frozen seas.

A very large portion of the polar islands are volcanic, and on many of them there are mighty, active volcanoes. Iceland is one of these, and in many parts of that island are immense geysers and hot springs which warm the earth and temper the climate appreciably, while this far northern island is still further warmed by the Gulf Stream so that man can dwell there and can raise crops and cattle during the short summer. It is upon these islands of the far north and south that we may best see the effects of ice and snow and frost in the formation of the islands. I have already spoken of the glacial boulders, the glacial scratches and the glacial drift and other effects of the vast river of ice which once covered the northeastern portion of North America; but while these are very interesting, as telling the story of long-past ages, it is far more interesting actually to see glaciers at work and in such northern islands as Greenland, Iceland and Spitzbergen, or on

similar islands in the Antarctic, we may see exactly how the ancient glaciers carved out the valleys and formed the hills and sand-bars and islands in those long-past days when our own country was buried beneath thousands of feet of moving ice. Many of these polar islands are almost entirely covered with a vast ice cap many thousand feet thick.

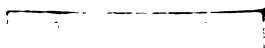
The entire interior of Greenland, except a narrow strip along the coasts, is buried under a stupendous mass of ice whose rounded or convex surface rises to 9,000 feet above the sea. On this immense stretch, 1,500 miles in length by 700 miles in width, no sign of rocks appear, for all the great mountains are hidden under the accumulated snows of countless centuries. Here is no vegetation, no animal life, no streams of water, but only the trackless, unbroken waste of white swept by howling gales and blizzards. Upon the surface the snow is soft and light from recent falls, but beneath this the snow becomes harder and harder until it is altered to dense impenetrable ice formed by the solidification through cold and the weight of the multitude

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of snows which have fallen through the ages since the island was formed. But despite its solidity and its immense thickness the tremendous mass of ice is not stationary, but is ever moving slowly in all directions from its centre towards the sea, exactly like a stupendous accumulation of pitch. And, like a mass of pitch flowing and spreading outwards from the centre, the edges become thinner and thinner until the coastal hills and mountains are exposed and the moving masses of ice flow silently between the ridges and the peaks until they reach the sea or plains. These river-like masses of ice moving seaward between the mountains are known as glaciers, and many of the largest of them reach the sea in inlets or fjords. While the faces of these may be 200 or 300 feet in height, yet they are often 2,000 to 3,000 feet in thickness, for the greater portion of the ice is beneath the water. As the mass is constantly being forced outward by the pressure of the ice behind, and as there is no support save the sea, large masses are constantly breaking off and floating away as icebergs, so that the snows which fell thousands



THE SHORE OF AN ARCTIC ISLAND.



of years ago in the interior of Greenland melt at last in the warm waters of the Gulf Stream thousands of miles from the northern island.

Just as the flowing streams and rivers and the winds are ever carving and cutting and wearing and forming the surface of the land and the islands in the temperate and tropical zones, so the vast ice cap and the irresistible glaciers are carving and grinding and wearing away the surface of these Arctic and Antarctic islands exactly as did the glaciers and the ice cap which covered our northern states in the glacial age. What is going on beneath the stupendous mass of ice we can only imagine, but by studying the smaller ice rivers or glaciers we can learn just how the moving ice is moulding and altering the land, cutting down and wearing away in one spot and building up in another. Although the largest of the glaciers reach the sea and break off into icebergs the smaller glaciers go no farther than the plains and beaches of the coasts, and here we can best see how the glaciers are formed and how they act. Many of these glaciers end in towering ice cliffs or preci-

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pices as sharply cut as though sliced off with a gigantic knife, and in such places their structure is easily seen. And we will find by examining them that, instead of being composed of a homogeneous mass of clear ice as we might expect, they are stratified like cliffs of rock, each layer representing successive falls of snow in the distant interior of the island. The soft upper layers are white and clear and free from many stones, but below this each layer is darker and more thickly studded with stones and gravel and is more compact, until at the base the most ancient layers of solidified snow are so filled with sand and pebbles and rocks as to be scarcely distinguishable from the surrounding land.

And piled about the foot of this ice cliff are many tons of sand and gravel and boulders which the glacier has dragged with it and which have been released from their icy bonds as masses have broken from the face of the glacier and have gradually melted in the sunshine. This material is known as *drift*, and if we examine it we will find it exactly like the masses of gravel and stones which we find

upon our shores and plains and islands in the portions of the United States and Canada which were once beneath the ice. The stones are of many kinds and of all shapes and sizes, with many of them worn flat and polished or else deeply scratched upon one side where they have been dragged over rocks under millions of tons of ice. So, too, where the surface of the ice wall has been broken and melted away we find the rocky ledges beside and beneath it deeply scored and worn smooth in the same way that the granite ledges on our island in the lake were worn and scored.

Now that we have seen the glacier and know of what it is composed, let us clamber upwards over the sharp-edged volcanic rocks and view the ice-river from above. Looking down upon it the glacier appears like a white ribbon winding in great, graceful bends and curves between the black rocky ridges and peaks and connecting the far-distant mountainous mass of everlasting snow with the sheer cliff of ice at the coast. Indeed, it is strikingly like a river flowing from an immense lake to the sea, and this, in fact, is what

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or less crescent-shaped and known as *terminal moraines*. Added to this is the mass of gravel and rocks which are carried enclosed in the ice or dragged along at its foot, and as the surface moraines are composed of unworn, angular stones, and as those dragged beneath the ice and ground over the ledges are worn and polished, we can always recognize a glacial ridge or moraine by its miscellaneous assortment of worn and unworn pebbles, boulders and rocks, many of which are ground to a flat surface on one side or are deeply scored or grooved.

The Greenland glaciers have but few stones upon their surfaces as compared with those of the Alps or other countries; but they carry vast quantities of drift locked within them, and this results in clogging of the ice in greater or lesser degree, according to the amount of debris within it, causing the various layers or strata to move or slide upon one another so that the seaward faces are often curiously like gigantic steps or overhanging shelves.

Very often we find tunnel-like openings at

the foot of a glacier, and with good-sized streams of ice-cold water gushing from them, for, as the sun melts the surface of the glacier, the water trickles down through cracks and crevices until it reaches the solid rock beneath the mass and flows forth beneath the ice to lose itself in the sea or to form little lakes in the terminal moraine.

I have spoken of glaciers as of solid masses of ice, but in reality a glacier's surface is usually broken and cracked with huge chasms known as *crevasses*. Although the ice moves bodily forward, yet it is quite plastic and its surface moves more rapidly than its foot, which is held back by friction against the earth, and its centre moves faster than its sides for the same reason, exactly as the current of a stream is fastest in its centre. But the elasticity of the ice is not great enough to permit it to follow steep slopes or sudden curves without breaking, and when the ice comes to an abrupt slope or drop, strains are produced which break great transverse fissures in the ice mass. These transverse crevasses may be many feet or only a few inches in width and

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may be hundreds or even thousands of feet in depth.

Other crevasses are known as *marginal crevasses* and are produced by the centre of the glacier moving much more rapidly than the edges or by its turning sudden bends or corners, while still another form known as *radial crevasses* are produced when the narrow ice river reaches a broad plain or valley and spreads out. Perhaps you may wonder why many of these great streams of ice should come to an end before they reach the sea. The reason is that every glacier ends where the supply of material from which it flows is balanced by the rate of melting or breaking up at its termination. Thus those glaciers which flow from large ice-caps where there are heavy snows flow much farther than those which originate in snow-filled amphitheatres, and those which are exposed to the sun end sooner than those which are in sheltered or shaded places, while glaciers in the far north and south, where the load of snows which fall annually are in excess of the amount of ice broken and melted from the

glaciers in the short summers, usually end only when they reach the sea and can go no farther.

And now, having learned something of glaciers and their ways, let us examine the exposed surface of the polar island and see what effects the ice has had and how much it has done to form the island.

Although, in a way, the work of a glacier is much like that of a river, yet its action is very different. The river or stream is swift and comparatively small, and its course fills but a small portion of the valley where it flows, whereas the glacier is slow, huge and fills the greater part of the valley. While its rate of flow may be only one millionth that of running water on the same grade, yet its other properties more than counterbalance this. Although glacial ice is elastic yet it is solid and is only pliant under tremendous pressure, whereas water is mobile and adapts itself to every curve and inequality. Streams push and roll the stones and gravel along their beds and cut away the banks and rocks by slow erosion and undermining, and their ability to carry drift



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and to cut through rock and earth depends entirely upon their velocity. On the other hand, the glaciers can carry enormous loads upon their surface, as well as dragging drift beneath them, and the amount of drift they carry is limited only by the amount of material which is broken or worn from the mountain sides above them or from the valley's sides and bottom.

Moreover, as the ice does not readily conform to sharp bends and inequalities and its power to cut away rocks and earth is practically irresistible, its erosive qualities are far greater than the largest of rivers. In addition the glacier, in filling the valley to great depths, carries off immense quantities of debris from the sides of the valley which, if cut away by a stream, would merely fall down the slope to form piles of talus. Thus, a valley or a country worn and carved by glaciers is almost bare of loose sand, gravel and stones save where such materials have been dropped by terminal moraines.

And the bed beneath a glacier is also very distinct from that under a stream. The latter

is composed of fine sand or gravel and smooth, rounded, water-worn stones, or of grotesquely and unevenly worn ledges and rocks, whereas the bed of a glacier is formed of stone-filled, dense clay compressed by the immeasurable pressure of millions of tons of ice, or, in the case of rocky bottoms, it is worn smooth and polished, with deep scores or grooves and a rounded surface. Oftentimes the bed of a glacier may be composed of both these types and we find broad, deeply-scored and smoothed surfaces of rock alternating with beds and areas of clay, with the rocks rising in rounded low ridges like billows. This is brought about through what is known as "*plucking*." If the rock over which the ice river passes is hard and fine grained the gravel and stones carried by the glacier will wear and cut and plane down the bed-rock to a smooth, even surface; but if the rock is soft or brittle or jointed the moving ice breaks up the rock, tears off projections, forces the cracks and crevices apart, dislodges the pieces and, freezing fast to the fragments, drags them onward as it proceeds. Then the fol-

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lowing ice, with its load of gravel, stone-dust and cobbles, smooths off the remaining rocks and pack the spaces between them with sand and clay. Such rounded, billowy ridges of rock are known as *Roches moutonnees* or "sheeps' backs" and are very common in many places, as about New York City. Very often, too, we may see good-sized hills or small mountains with one side rounded smoothly and with the other craggy and sharply cut, showing where a glacier wore away one side, and as these rounded hills and "sheeps' backs" are always more pronounced on the side against which the ice stream moved we may easily trace the direction of the flow of the ancient glaciers by examining the worn ledges and hillsides.

Moreover, it is easy to distinguish a glacial-formed valley from one produced by a river, for the huge, slow-moving glacier produces a wide, flat-bottomed valley with the sharply-cut and jagged peaks rising precipitously above it on either side, while the valley cut by a stream is narrow at the bottom with sloping sides or, in other words, a glacial val-

ley is "U"-shaped, whereas a river valley is "V"-shaped. On all Arctic and Antarctic islands these "U"-shaped valleys are prominent, and many of them end in "*Fjords*" or steep-sided inlets of the sea which are merely glacial valleys which were formed by immense ice streams gouging out the land below sea level, or else were once above the sea and have been lowered to their present position through submergence of the land. Another feature of the valleys and mountains scoured by glaciers is that the branching or smaller valleys join the main valleys at some considerable height above the floor of the latter. This is due to the fact that the main glacier requires a much deeper channel than its tributaries and that the depth of a glacial valley depends upon the weight and size of the ice mass, whereas a very small, rapidly-flowing river may cut a channel as deep or even deeper than a larger, more slowly flowing stream. The result of these branching glacial troughs, at some height above the main glacial valley, is that in all northern islands which have been cut by glaciers we find what are known as "hanging

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valleys," and as these are usually occupied by streams, nearly all the islands of the far north and south have high and beautiful cataracts.

Still another effect of glacial action is the existence of beautiful land-locked lakes which occupy basins produced by glaciers which have disappeared. These basins are formed by the glaciers scoring out deep channels where their weight and motion are greatest, while near their ends where they are reduced in weight by melting and their movement is checked by more level land, a moraine or accumulation of sand and gravel is produced which serves as a dam and holds the water which accumulates after the ice disappears. Another crescent-shaped form of basin or lake is produced by glaciers which rise in amphitheatres among mountains. Just as a large spring of water gradually wears back a recess in the hillside from which it gushes, so the head, or source, of a glacier gradually wears back into the mountain side to form a circular or semicircular basin known as a "*cirque*." And as this basin wears backward the surrounding mountain sides the peaks above are

steepened and sharpened until they tower precipitously above the cirques and end in scalloped, knife-edged ridges. Then, with the disappearance of the glacier, or when it melts during the summer, these basins are filled with water and form placid, beautiful lakes reflecting the lofty mountain peaks which rise above them.

But aside from all these direct actions of glaciers in forming islands there are secondary or subsidiary effects brought about indirectly through the glacier's presence. Thus, as long as a glacier fills a valley, the latter is protected from rain, wind and other forms of erosion, while the peaks or mountain sides above the ice are exposed to them, with the result that the valleys of Arctic and Antarctic islands are usually broad, smooth and rounded, while the peaks and ridges on either side are jagged, sharp-edged, angular and needle-like. In fact, the difference is often so great as to give the effect of the mountains being composed of two totally distinct kinds of rock. And as the drift left by the gradually receding glacier often fills the valley to great

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depths, and as the debris from the steep mountains is washed and swept into the valley and gradually decomposes to form earth, the valleys of these islands of the frozen seas are often rich and fertile and pleasant, while the surrounding mountains are forbidding, barren and bare naked rock.

Now that we have studied the effect of the ice upon our Arctic island let us turn to its other features and the forces of Nature which have combined to form it. Here, of course, we find no coral reefs, no Aeolian limestone, no wind-drifted, lime-cemented coral and shell sand; but along the coasts we may find towering cliffs and ledges of limestone composed of countless millions of fossil marine animals. In many cases these are of forms which now dwell only in tropical seas, such as corals, gorgonias and certain shells and crustaceans, and these and their abundance go far towards proving that at one time these islands of the frozen zones were washed by the warm waters of the tropics and supported a dense, luxuriant vegetation and a teeming life, for, on many of them, we find great numbers of

fossil plants which could have only existed in a warm climate. And the height above the sea at which we find the fossil marine animals proves that these islands, like others we have visited, have been raised for thousands of feet above their original level. Moreover, we may at times find alternate layers of fossils and limestone and lava or we may find fossil land animals and plants under vast beds of marine animals, thus proving that these islands have been submerged and elevated many times in succession, just like islands elsewhere.

Finally, there are the volcanoes and the volcanic action on these desolate bits of land in polar seas. In many, volcanoes have played the most important part in their formation. Many of the cliffs are ancient lava flows; most of the rocks are igneous or volcanic, and all the fertile land or soil is composed of decomposed scoriæ or cinders. But, as a rule, we will find these islands to be formed of a combination of various rocks, just as we found the tropical islands were partly volcanic and partly of limestone formation, and we will also discover that, aside from superficial dif-

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ferences, due to climate, the islands of the polar regions are very similar to those of equatorial seas or temperate zones. If the climate should change so that the Arctic or Antarctic oceans became warm, or if the island we have studied could be transported bodily to the tropics, changes would take place which would leave it, in the course of time, exactly like any other island. Gradually the tropic rains and winds would eat away and break down the steep mountains and the debris would fill the broad glacial valleys, and through these the tumbling streams would cut new "V"-shaped valleys leading to the sea. The fjords would become filled with coral and in time would be transformed to rounded coves ending in snowy beaches of broken shell and coral sand. The mud and ashes thrown out by the volcanoes would remain in immense piles, and instead of being carried away by the resistless glaciers it would be furrowed and cut and terraced into rounded hills by tropical showers. Vegetation would spring up and hide the scarred and weathered rocks and would clothe the valleys and the hills with

green. The falling leaves and dying stalks and trunks would rot and form deep layers of vegetable mould to support a still more luxuriant growth. Bright-hued birds and insects would find a pleasant home upon the island; the wave-torn, ice-cut shores would take on softened lines and would be overgrown with corals and protected by coral reefs, and numerous beaches would appear, and in the end none but a geologist would ever suspect that the island had ever been buried under a huge ice-cap, and that mighty glaciers had plowed their way through the valleys, or that wave-tossed icebergs had had their birth within its fjords. But the geologist, examining the sharp-cut river banks, would find the miscellaneous unassorted mass of gravel and stones and flattened rocks which could only have originated as glacial moraines. On bare exposed ledges or mountain sides he would find the deeply-scored parallel marks where hard rocks had been dragged along beneath millions of tons of ice; he would find traces of hanging valleys and cirques; his trained eyes would pick out sheeps' backs from rain-

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rounded masses of scorix, and by a hundred ways he would know that while tropical and luxuriant and inviting at the time, yet in past ages the isle was swept by howling blizzards and washed by ice-filled seas; that its interior was buried beneath a mighty ice-cap, and that its verdant valleys were filled with great rivers of slowly moving ice, for geology is the key that unlocks the secrets of the earth's past and tells us the story of what took place millions of years ago, no matter how carefully Nature has tried to conceal it beneath a covering of verdure or how much climate and conditions may have altered.

THE END

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OCT 15 1968



